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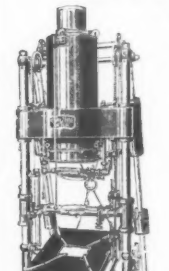

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PROPOSED BRITISH NATIONAL PARKS FOR AFRICA:

A paper read at the Evening Meeting of the Society on 9 March 1931, by

MAJOR R. W. G. HINGSTON

WITH the approval and support of H.M. Secretary of State for the Colonies and at the request of the Society for the Preservation of the Fauna of the Empire, I proceeded on 23 May 1930 to the East African group of Colonies and Dependencies in order to discuss with the Governors, Game Wardens, and other interested persons the future policy regarding wild life. The Joint East African Board approved of and supported the mission. I proceeded first to Northern Rhodesia, then to Nyasaland, Tanganyika, Kenya, and Uganda. After full discussion with Government officers and representatives of public opinion a scheme of ten national parks was drawn up and submitted for consideration to H.M. Government. It is believed that this scheme if made effective would ensure the perpetual preservation of the fauna of these territories without undue interference with native rights or economic development.

Necessity for National Parks in Africa

It is taken for granted that the preservation of the wild life of Africa is an object worth achieving. Admittedly this view is not universal. There are persons who regard the wild life of a country like the gorse in a meadow or the weeds in a garden. It is nothing but a pest which requires to be eradicated. The Boers, when wiping out the game on their farms, used the expression "cleaning" the land. It illustrates the point of view that certain persons still hold and apply to the whole African continent. The view need not here be contested, since in British Africa the large majority of people are in favour of the reasonable preservation of wild life.

Of all the assemblages of wild animal life that of Africa is by far the most important. In the abundance and variety of its constituents, in the immense size, the unique character, and what we must call the prehistoric appearance of its examples there is nothing to compare with it in any other continent. The elephant, rhinoceros, hippopotamus, giraffe, okapi, gorilla are perhaps the most impressive manifestations of the creative force that to-day exist on the Earth. Fortunately it is an expression of general feeling that the final extinction of these extraordinary creatures would be a gigantic calamity. Nevertheless it

is equally true that these and many other types of the African fauna cannot under existing conditions hope to survive far into the future. It is as certain as night follows day that unless vigorous and adequate precautions be taken several of the largest mammals of Africa will within the next two or three decades become totally extinct. Should that occur then assuredly we shall have abused a trust and future generations will judge us accordingly.

Every large animal of whose extinction we have any record has been eradicated by human agency. Confining ourselves to the African fauna, the great blaubok, which inhabited Cape Colony, was annihilated by the farmers in the year 1800; the quagga, which covered the plains of South Africa, was exterminated by the Boers in 1858; the typical form of Burchell's zebra, which existed in British Bechuanaland, became extinct about the year 1910. Certain other species have been so reduced that they may be said to border on extinction. Take for instance the white rhinoceros. Within the lifetime of many of us still living the white rhinoceros abounded in the African continent from the Vaal to the Zambezi. To-day it is reduced to twenty individuals in Zululand and 130 individuals along the upper reaches of the Nile. It has been exterminated over half a continent within a space of fifty years. The gorilla, nyala, Grevy's zebra are species which have shrunk to minute numbers and are on the verge of disappearance. The whole African fauna is steadily failing before the forces of destruction brought to bear against it. Great and small, everything is retreating. And the saddest aspect of the melancholy picture is that it is the largest and most extraordinary examples which are yielding most rapidly in the conflict. I doubt if any of the three great pachyderms, the elephant, rhinoceros, and hippopotamus, will, if present conditions continue, survive beyond the next fifty years.

What are the forces that are causing this annihilation? They may be divided into four classes: (1) the spread of cultivation; (2) the demands of trade; (3) the activities of sportsmen; (4) the menace of disease.

1. *The spread of cultivation.*—In Africa cultivation is incompatible with wild life. Man, once he cultivates an acre of soil, will not tolerate wild animals in his vicinity. They cause him injury in a number of ways. Elephants, for instance, do tremendous damage—breaking down fences, trampling banana plantations, tearing off bark, eating vegetation, and perhaps destroying in a single night the village food-supply for the whole season. The buffalo is particularly fond of maize, though it usually tramples more than it eats. On the banks of lakes and rivers where rice is grown the hippopotamus can be a terrible nuisance. Zebras break down fences by the sheer weight of their numbers. The duiker family can be very mischievous where cultivation fringes forested areas. The eland leaps over fences to get at crops. The kudu is indicted with the same offence. Even the giraffe, hitherto regarded as innocent, is at last beginning to vary its diet of thorns with man's more juicy crops. But the damage done by all these animals combined is probably slight compared with the ravages of baboons and pigs. These destructive brutes tear and root in all varieties of cultivation and are naturally and rightly classified as vermin.

In addition to the ravages that occur in cultivation the settler has to cope with the likelihood of menace to himself and his domesticated stock. Lions destroy his cattle and goats. Leopards carry off calves, goats, sheep, dogs, and

fowls. Wild dogs will play havoc in a herd of goats. Hyenas, though often thought to be pure carrion feeders, will destroy any kind of young stock, and probably do as much damage as the three other carnivores put together. Then the settler's life and that of his employees are open to danger. Many casualties amongst human beings are caused by buffaloes, which sometimes charge without provocation. Lions from time to time become dangerous man-killers. Leopards less often become similarly degraded. The hippopotamus in places attacks man on sight, and makes certain lakes almost unnavigable by its aggressive habits against canoes. Even the cowardly hyena has been known to enter huts and carry off young children.

Now the settler will not stand this kind of thing. He has put his effort and his capital into the soil and he will not have it wrecked by the ravages of wild beasts. He will drive the enemy from his neighbourhood; nothing can save it; no game laws and no restrictions can ever prevent the wild life from being eradicated in the vicinity of settlement and cultivation. Legislation can protect it from the rifle; it can do much to check the cupidity of trade; but it is powerless to prevent the wild life retreating before the advance of civilization. Nor can any scheme of conservation hope to succeed if it aims at preserving animal life at the expense of human progress. In Africa the spread of human settlement is everywhere disturbing and pressing back wild life. It is not that the animals get shot out near a settlement, but they quickly learn that the district is unhealthy, and in consequence they withdraw some 20 miles from the settlement, where they find themselves free from continual molestation. The process is therefore very gradual. Settlement slowly spreads; the wild life retires; year by year it is driven farther afield into areas that are still waste.

There can be no doubt that as the years go on settlement and cultivation will increase in Africa. The native is being instructed in better methods of agriculture, and irrigation is coming into use. He is being educated and civilized. He is receiving modern medical and sanitary attention which will both diminish infantile mortality and increase the average length of life. All this must bring about a growth in population, spread of cultivation, and wider settlement. The future picture of Africa must be one with a much larger and more civilized population and containing vast areas of cultivated land where there is now desert and bush. The result of this on the wild life will be to drive it ever farther afield; and if we look ahead into the far future we must picture a time when the wild life of the continent will exist only where there happens to be a sanctuary. If this picture is a true one and if the wild life is worth preserving, then these sanctuaries must be made as permanent and as stable as it is within the power of man to make them.

2. *The demands of trade.*—Trade is the arch-exterminator of animal life. Cultivation we have seen drives the wild life into the wilderness, but so long as any wilderness remains, there the wild life will keep some kind of foothold. The demands of trade, on the other hand, are utterly relentless. They have no limit; they follow the wild life into the farthest fastnesses and annihilate it to the last individual. It was trade in skins that exterminated the quagga and swept the animal herds from South Africa. In America trade fell so relentlessly on the bison that the hides were often removed from one side of the animals only, it being easier to kill others than to turn the huge beasts over. It was trade

in feathers that swept the great auk from the Atlantic, trade in oil that swept the whales from the Arctic, trade in horn that reduced the white rhinoceros to its present state of all but extermination. It is a maxim of undoubted truth that trade in wild life means butchery and the ultimate extermination of that life.

It would make a long list to mention all the ways in which trade can press on the wild life of Africa. I have space for only a few illustrations. The elephant carries ivory saleable all the world over. The rhinoceros has horns esteemed in China as an aphrodisiac and more valuable even than ivory. The hippopotamus has teeth which find a ready market as an inferior brand of ivory. The hides of the buffalo and zebra are saleable for leather. The giraffe supplies several things bartered by natives: its meat for food, its hide for leather, its tendons for bow-strings, its tail-hairs for bracelets. The skins of the blue duiker, colobus monkey, blue monkey, and others are saleable for making rugs and coats. All the game animals supply meat which can find a ready market. Fortunately trade can be controlled, and regulations of the very highest importance do so control it in our African possessions. Were it nor for the existence of such regulations and the efficient manner in which they are administered the wild life of Africa would be swept from the continent in an incredibly short period of time.

3. *The activities of sportsmen.*—It is commonly thought that the visiting sportsman is responsible for the decline in the African fauna. That is not so. The sportsman does not obliterate wild life. True, he kills. But seldom is his killing wholesale or indiscriminate. What the sportsman wants is a good trophy, almost invariably a male trophy, and the getting of that usually satisfies him. Ordinarily he is content with a few trophies from each species, and he discriminates with respect to sex. The natural reproductive capacity of the species easily makes up for that degree of wastage.

The position is not the same with the native hunter. He cares nothing about species or trophies or sex, nor does he hunt for the fun of the thing. What the native wants is as many animals as possible for the purpose either of meat or barter. When he hunts as an individual with his primitive weapons with the object of killing everything obtainable he probably does not cause any greater destruction than does the discriminating sportsman with his modern weapons. But it is otherwise when natives hunt collectively. They have then the power to cause serious depletion through the wholesale and indiscriminate methods employed. For instance, it is a practice in Northern Rhodesia for a crowd of natives to drive herds of lechwe into rivers and despatch them in hundreds with spears. In Tanganyika up to a few years ago whole herds of animals were harried against fences which forced them into concealed pits. In Nyasaland it is a type of native hunting to make circles of bush-fires round animal communities, which results in the beasts being burnt to death or escaping terribly scorched. It is a widespread practice to sit with poisoned arrows over water-holes and shoot at every animal coming to drink. Still another plan is to lay out long lines of nooses suspended from a rope 4 feet above the ground. The herds are driven on to the contrivance, which is devilishly effective and captures everything from zebras to gazelles. All these methods are wholesale and indiscriminating in their destructiveness. They are contrary to law in the

British territories of East Africa, but the letter of the law cannot always run over the immense tracts of country involved.

4. *The menace of disease.*—The relation of the wild life of Africa to disease from time to time provokes terrible destruction and raises the outcry for complete extermination. On this pretext there were annihilated last year in Zululand 20,000 head of game, including 9000 zebra and 2500 wildebeest. The amount of slaughter which has taken place during recent years in Southern Rhodesia with the mistaken idea of eliminating disease is beyond calculation and horrible to contemplate. The tsetse fly is the agent that carries nagana to cattle and sleeping-sickness to human beings. Also it feeds exclusively on blood and obtains most of the blood it requires from the large game mammals of the country. Hence it is easy to understand that when these diseases are rampant the cry should arise for game extermination. If it were a fact that the removal of the large mammals from Africa would solve the problem of these terrible scourges then the animals would have to vanish; wild life must not be permitted to thwart the advance of civilization. But the problem is far more complicated than this. The tsetse fly feeds on many animals in addition to the big game, for example, on baboons, pigs, rats, mice, lizards, crocodiles, and so on. There is in practice no clear relation between the numbers of tsetse fly and the abundance of game. Vast areas of Africa teem with game and do not contain a single tsetse fly; other areas abound in fly, yet game have not been seen on them for years. It is certainly possible that if every breathing thing was swept out of Africa the tsetse fly might at the same time vanish. But no good can come from removing the large mammals only. Experience has demonstrated that it never has done good and on certain occasions it has done great harm. What happens in these attempts to eradicate a mass of game is that the animals, instead of being exterminated, are scattered widely and the fly is carried with them into distant areas which had previously been free from infection. A great holocaust of slaughter is associated with the scattering, but as soon as the carnage ceases the animals return to their old haunts. This disturbance of nature can not only spread disease but can actually provoke in it the locality. For example, the natives destroyed a quantity of game in one area of Tanganyika, with the result that the fly, being deprived of its host, turned its attention to the natives and caused a serious outbreak of sleeping-sickness. In other places the fly, after a similar holocaust, attached itself to the domestic cattle.

The truth is that our knowledge of this whole problem is imperfect. These periodic demands for game annihilation are not based on scientific knowledge; they are emotional outbursts for something drastic to be done on the part of people who are suffering serious loss. One sympathizes with settlers when they see their stock vanishing; but one thing is certain, that wholesale game destruction will fail to give them the relief they look for. Hitherto it has always failed in its object. Nevertheless, the demand repeatedly arises and it must be regarded as a serious menace. In the present imperfect state of our knowledge any wholesale removal of the big game of Africa would be nothing but a horrible catastrophe.

It must be clear that the preceding four classes of operations constitute a very serious menace to the existence of the wild life of Africa. Nature's

recuperating powers are tremendous, but are they sufficient to keep an even balance against this combination of destructive forces? Almost certainly not. There is taking place to-day in East and Central Africa exactly the same eradication of wild life as took place in South Africa and the United States. The process is no doubt distinctly more gradual because the spread of civilization happens to be slower; but it is absolutely certain that this combination of forces—the spread of cultivation, the demands of trade, the activities of sportsmen, the menace of disease—is demolishing the wild life of the continent. The most wonderful thing in Africa is its animal life. It has probably been the wild life more than any other factor which has been responsible for attracting the Englishman to Africa and establishing in our colonies a white population. Its disappearance through any short-sightedness or neglect would be a deplorable calamity.

How can this complex problem be dealt with in such a way as to lend some hope of preserving the species far into the future? There would appear to be only one way. The human life and the wild life must be separated permanently and completely. So long as man and animals live together there will always be complaints and serious trouble. In one place the complaint will be that the crops are ruined, in another that the wild life kills domesticated stock, in another that it terrorizes the district, in another that it spreads disease. Then the sporting instinct can never be repressed so long as game lives in the vicinity; nor can we expect that man will cease to kill when an opportunity arises of bartering the spoils. This problem admits of no permanent solution until the human life and the wild life are separated into two completely distinct compartments. This means that, if the animal life is to be preserved, it must be segregated in a sanctuary. But the sanctuary must be a real and an inviolate institution, one which, in so far as human effort can make it, is a sanctuary for all time.

Status of the National Park

It will be said that Africa has many sanctuaries in which the animal life is not molested and where no kind of hunting is permitted. That is true. The Game Reserves of Africa are most important institutions. They have been and are still of the utmost value in preserving the wild life all through the continent; without them the abundance of the game of Africa would be very different from what it is to-day, and more than likely certain species would have passed into complete extinction.

The weak point about the reserve is its insecurity and want of permanency. It is brought into existence by a Proclamation in the local Government *Gazette*, provided that the Secretary of State agrees. It can be removed by the same easy means. Should at any time a demand arise for a portion or the whole of a game reserve to be allocated to some other purpose, as, for instance, agricultural development, it is not easy for even the Home Government to resist the demand, and in practice it is not always resisted. In point of fact the game reserves of Africa are from time to time contracted, abolished, or altered in some way by this simple type of legislation. It is only a matter of time before a public demand will arise for the reserves or some portion of them to be thrown open, and there is no guarantee that any game reserve in Africa will last over an extended period. Permanency and inviolability are the very essence of

sanctuaries, and it cannot be said that the game reserves are on a higher level than that of valuable makeshifts.

The national park, in contradistinction to the reserve, is placed by legislation on a more stable basis. It possesses a title. It is made by Act of Parliament the property of the public for ever to be utilized for the sole purpose of preserving the natural objects within it. It cannot be abolished or altered in any way except by subsequent Act of Parliament. This is the most secure and rigid status that can be given to a wild-life sanctuary. It alone offers any reasonable hope that the sanctuary may last into the distant future.

America has shown the lead in this matter. There are twenty-one reservations in the United States, administered by the National Parks Service of the Department of the Interior. As stated in the Act establishing the National Park Service, their purpose is "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations."

There are only two institutions in Africa which at present possess that likelihood of permanency implied in the status of a national park. One is the Kruger National Park of the Transvaal, established in the year 1926. The other is the Parc National Albert of the Belgian Congo, established in the year 1925. Both of these have some reasonable prospect of surviving the economic importunities of civilization. It is the belief of all who desire the perpetuation of the fauna that national parks on this rigid basis should replace the fluent reserves.

Certain objections are bound to be raised against the formation of such permanent institutions. There is the individual who considers it a grievance that he is not allowed to pursue game wherever his fancy takes him; also the type of settler who regards it an injustice that an area of land should be maintained solely as a paradise for wild beasts; also the person who likes to allege that efforts are being made to preserve dangerous animals which are nothing but a public menace. These classes of persons are usually cranks and their objections carry little weight. A more serious objection sometimes raised is the inadvisability of tying up land for a sanctuary while our knowledge of the tsetse-fly problem is imperfect. But this objection could carry weight only if the sanctuary happens to be inhabited by man or his domestic animals.

Requirements of the Ideal National Park

It is obvious that land cannot be tied up in this way without a great many factors being taken into consideration. The most important must be discussed briefly.

1. A park ought to contain as far as possible all the types of animal life characteristic of the country in which it lies. This is true of the large parks. The balance of nature should continue uninterrupted, carnivores destroying herbivores in accordance with the natural scheme of things.

2. It ought to be reasonably well stocked. Once an area is proclaimed a sanctuary there is certain to be a regular and fairly rapid increase in the number of its animal inhabitants. But the fact of its being well stocked at the beginning is the only ground for deciding with certainty that it is capable of supporting an abundance of wild life.

3. It must be of adequate size. This is important from the point of view of migration. Many of the large African mammals are accustomed to move over long distances from one grazing ground to another or from water-hole to water-hole. Antelopes may have to go to and fro over distances of 40 or 50 miles. Elephants may make annual journeys over 100 miles or more. The park must be sufficiently large to cover the whole extent of these yearly migrations. An area of from 2000 to 8000 square miles should be aimed at for a park of this description. Smaller parks of less than 100 square miles in area will be required for the protection of certain rare species, such as the bongo in Kenya and the nyala in Nyasaland.

4. It must hold a sufficiency of animal food at all seasons of the year. The problem of water is more difficult. Large areas of Africa are decidedly arid. Streams and water-holes are often few and temporary. It is a matter of the first importance that the supply of water should be adequate.

5. It ought not to contain land the development of which is essential to the territory. Cultivation is possible within a park, and is carried on both in the Kruger National Park and in several of the national parks of America. But in Africa cultivation so conflicts with the wild life that every effort should be made to reduce it to a minimum. Settlement or cultivation on a large scale could scarcely hope to be successful in a properly regulated African sanctuary.

6. It ought not to hold minerals of economic value. This does not mean that payable minerals could not be worked within a sanctuary. But as a general principle both mining and prospecting are contrary to the regulations governing national parks and special modifications in the regulations will be necessary should minerals happen to be discovered within them. The State geologist should pronounce the area unremunerative before it is selected for a national park.

7. It ought to contain the fewest human inhabitants possible. In Africa European settlement could not be tolerated within a national park. In the Kruger National Park the settlers have been either bought out or compensated with land of equal value outside. Private land held within the parks of the United States has been a source of much difficulty. Congress has recently adopted the policy of making an annual grant of $50,000 for the purchasing of private lands inside national parks, to be made available only when an equal amount is contributed for the same purpose from other sources. If natives are allowed to cultivate inside a park there are certain to be continual complaints. The only real solution is to arrange for their removal to suitable land outside park limits. Cattle-raising people, like the Masai, are likely to remain more contented in a park. Since they neither kill wild animals nor cultivate the ground they are adapted to live with their animal neighbours on more amicable terms than are other races. In the case of the Masai the complaint will be that the wild ungulates are taking the water and grass which would otherwise be available for cattle. Certain races, like the Batwa of Southern Uganda, live exclusively by hunting with primitive weapons. If they happen to be included in a national park it will be necessary so to modify the park regulations as to permit them to continue their hunting rights with their native spears and bows and arrows.

8. It ought to be accessible. This applies to such parks as are suitable for

development into places of instruction or holiday resorts. The more spectacular parks, when fully developed, can be made self-supporting or a source of profit to the State. This demands that they should be easy of access. Hence roads, rivers, railways in the vicinity of a park or running through it are likely to be distinctly advantageous.

9. It ought to contain as far as possible natural features of scenic and geographical interest, such as mountains, lakes, forests, waterfalls. The national parks of the United States and Canada exist in the main for their scenic attractions. Those proposed for Africa have chiefly a zoological interest. Nevertheless, the scenery is of considerable importance. Remarkable spectacles, such as the Ngorongoro crater, Kilimanjaro, the Murchison Falls, to mention only a few, which come within the limits of the proposed scheme, are scenic attractions of the first magnitude. It is the function of a national park not only to be a sanctuary for the wild life, but to preserve the natural features of the landscape in all their primeval grandeur.

10. It ought to be as far as possible healthy for visitors and possess a comfortable climate. In Africa healthiness is likely to mean freedom from malaria and sleeping-sickness. Malaria can be dealt with by the usual methods. The existence of tsetse fly within a park obviously diminishes its attractiveness to visitors, and if associated with sleeping-sickness may result in the whole or part of the park being temporarily or permanently closed. Special regulations will be required to secure the protection of visitors.

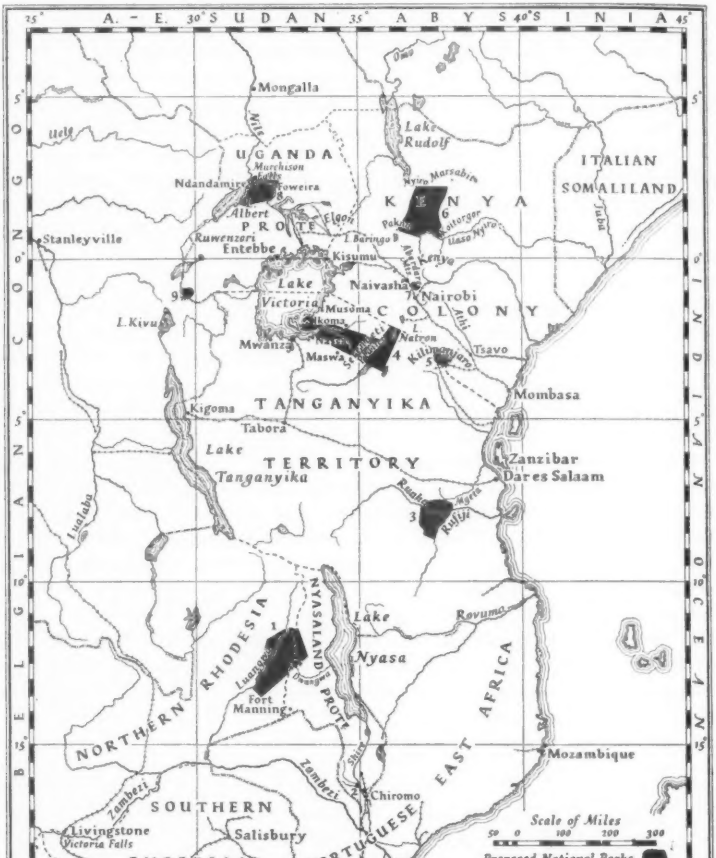
It is, of course, impossible in any proposed park to secure all the objects set forth above. But certain of the proposed areas come remarkably near to the complete ideal. It is important that national parks should be established before the wild life is on the point of vanishing. Both in South Africa and the United States it was not until the wild life was nearly exterminated that public opinion demanded action. Sanctuaries had to be formed at the eleventh hour in the face of serious difficulties and at great expense. Had they been established at an earlier date they would have been less costly and far better stocked. National parks can now be formed in East Africa at an expenditure which is almost negligible. Each year will add to the difficulties and the expense, and in the end public opinion will demand them.

Proposed Scheme of National Parks

1. *South-Central African National Park.*—It is most desirable that a large sanctuary should be formed to protect the magnificent fauna of South-Central Africa. The best solution would be the creation of a national park at the junction of Nyasaland and Northern Rhodesia. The Nyasaland contribution would come from what is now the Kasungu game reserve, a triangular expanse of waste territory, about 600 square miles in area, situated immediately north of Fort Manning. Its greatest width from east to west is 34 miles; its greatest length from north to south 55 miles, and it lies along the Nyasaland–Rhodesia border for a distance of about 70 miles. It is a grassy plain, hot and dry, and forms part of the great western Nyasaland plateau. In its northern part it is traversed by the Dwangwa river. The area is now given over completely to game, but suitable legislation would be required to raise it to the national park status.

In direct continuity with this area it is proposed that a national park be

established in the Luangwa valley of Northern Rhodesia. In the year 1914, when the territory was under the administration of the British South African Company, a game reserve existed in the Luangwa valley. That reserve has now ceased to exist. The valley is about to be surveyed and its game distribu-



Sketch-map showing the position of the Proposed National Parks in Africa, numbered as in Major Hingston's paper

tion studied in detail. It is hoped that on the completion of that work a suitable area of approximately 7000 square miles will be delineated for a park. The greater part of this valley is covered with moderate-sized trees making somewhat open forest. It is well watered by the Luangwa river and the large number of tributaries that enter its left bank.

There are several reasons why this combined area would make an excellent national park. It would shelter a very fine assemblage of the typical wild fauna of South-Central Africa. Large herds of elephant live permanently in it. It also contains rhinoceros, hippopotamus, buffalo, eland, giraffe, wildebeest, hartebeest, bushbuck, impala, kudu, reedbuck, roan, sable, waterbuck, zebra, lion, and leopard. It would include two species—the giraffe and the white-tailed gnu—which are very rare in Northern Rhodesia. Only a few small herds remain and are found in the Luangwa valley. It is sparsely inhabited. In the Nyasaland contribution there are no native inhabitants. In the Luangwa valley they average probably about three to the square mile. It offers no opportunities for European settlement. In the Luangwa valley there is very little cultivation; in the Nyasaland area it is completely non-existent. There is little likelihood of mineral activity either in the Nyasaland contribution or in the Luangwa valley. It is particularly advantageous that two sanctuaries should be continuous across the border. Large size and geographical continuity are essential in this type of national park. It is therefore more efficient from the point of view of conservation that the contributions from the two territories should be continuous instead of being separated as in other colonies. No administrative difficulty is likely to arise as a consequence of this arrangement. An important sequence of a park in this region is that it would solve the difficult problem of the elephant depredations that occur in Nyasaland. These depredations are caused by elephant herds that cross the border from Northern Rhodesia, and their most serious irruptions coincide with those periods when the Luangwa valley is thrown freely open to hunting and the elephants are harried in their main haunts. If the elephant was secured from molestation in the Luangwa valley, where at all seasons it has abundance of water and food supply, it is likely to remain in the valley, and the destructive irruptions into Nyasaland should cease. A national park in this area offers a possibility of economic development. Numbers of visitors come to the Victoria Falls and would go farther if a suitable attraction were offered them; and the experience of other countries demonstates that national parks can be made eminently attractive.

2. *Nyala National Park.*—The nyala is one of the rarest of the antelopes. It is of a shy, retiring nature, and keeps to dense forest and fever-ridden swamps. A few still survive in the Mkuzi reserve of Zululand, but owing to the recent demands for the abolition of that reserve, its existence there is extremely precarious. There are also a few in Portuguese East Africa south of Delagoa Bay and north of Beira, but their chances of survival cannot be great.

Its remaining haunt is in two small areas at the extreme south of Nyasaland. One area is known at present as the Lengwi game reserve. It is a quadrilateral-shaped block of land, about 7 miles long by 5 miles broad, situated between the Mwanza and the Nkombedzi rivers close to where they enter the Shire river. The other area is the Tangadzi reserve. It is only about 3 square miles in extent and is situated on the right bank of the Tangadzi river close to its junction with the Shire river near Chiromo.

These areas are well watered and covered in dense forest which has been occupied by the nyala from time immemorial. The Tangadzi forest is very thick and can be entered only by crawling along game paths. Its vegetation is quite different from that of the surrounding country, the trees being of enor-

mous size and festooned with lianas and creepers. It holds no settlement and is economically worthless. It is greatly to be hoped that these two small areas will be placed on the national park basis so as to ensure the protection of a species that is bordering on extinction.

3. *Selous National Park.*—It is proposed that the Selous reserve of Tanganyika should be raised to the status of a national park. It is a triangular area in the Mahenge district covering about 2600 square miles in the angle between the Ruaha and Rufiji rivers. From where these rivers join it has a prolongation to the north as far as the Mgeta river. Geographically it may be described as a vast wilderness of ravine-riddled ground intersected by many streams and in which there could be no development for the next thousand years. It is low-lying, hot, and unhealthy. Thorn dominates in the east; the west is more swampy; on the higher parts there is savannah forest. It is liable to inundation in the rainy season. The land in it is waste without possibility of settlement, and holds only a scanty native population. Certain coal-bearing rocks have been found in it, but they have not proved of commercial value. It has the sentimental interest of having within it the grave of that great hunter-naturalist the late Captain F. C. Selous.

The object in view in this proposal is the preservation of the African elephant. The elephant is the most harassed of all African mammals and its numbers, since the introduction of European firearms, have probably decreased more rapidly than those of any other species. The onslaught on the herds has been tremendous in the past, and there is little likelihood of diminution in the future. Nature's powers of recuperation cannot be better illustrated than by the way in which this huge, slow-breeding species has withstood the destruction brought to bear against it. Admittedly the big tuskers have failed in the contest and are now practically obliterated from the continent. The pressure is now falling on the smaller and less valuable ones, which are steadily on the downward path. In the Belgian Congo, for instance, there are about 25,000 elephants of all ages, yet from that colony there was exported in the year 1923 about 300 tons of ivory valued at nearly 30 million francs. In the combined territories of Tanganyika, Kenya, and Uganda there are probably about 60,000 elephants, and the value of the ivory exported annually from these countries is approximately £47,000. An immense amount in addition is smuggled out of which we have no record. The elephant is one of the slowest breeding of all mammals. It does not breed until thirty years of age and then produces one calf every five years. It is obvious that some kind of action is necessary if the elephant is to be checked in that downward path along which trade drives all its victims to oblivion.

The Selous Reserve of Tanganyika is at present a great stronghold of elephants. It also contains numbers of hippopotami. They abound in both the Ruaha and Rufiji rivers and in the soda lakes. The rhinoceros is well distributed through it, and there are in it several fine herds of buffalo. Eland are not very abundant, but there are several small scattered herds of five to twenty individuals. There are some fine herds of kudu, twenty-five to thirty strong, and a number of smaller herds. Sable are present only in small numbers. Zebra, wildebeest, and impala are very abundant and probably the most numerous of its large mammal inhabitants. Hartebeest are common

throughout the area. Waterbuck occur near the soda lakes. Bushbuck are well distributed and probably a few reedbuck occur. Warthog and wild pig are found all through it. Lions and leopards are numerous. There are in it several packs of wild dogs. Hyenas and baboons are everywhere abundant, and crocodiles infest the rivers.

It is one of the objects of a national park to be an attraction to visitors and a source of income to the country. That intention does not apply to this proposal, which is made solely with a view to animal conservation. The site could never be a park for tourists. It holds no scenic attraction, is not easily accessible, and the dangerous character of its animal occupants makes it unsuitable for the explorations of inexperienced visitors. As a place for biological research however it might prove of great value.

4. *Serengeti National Park.*—The most important sanctuary in East Africa will be the one designed to protect the common plains game in all their natural abundance and variety. The area proposed for this purpose is the well-known Serengeti Plains in the north-west portion of the territory. A most perfect park might be formed on those plains roughly demarcated as follows. The northern boundary to commence south of Musoma on Lake Victoria, thence to run east and slightly south of Ikoma, until it reaches the south end of Lake Natron, thence to run north along the west border of Lake Natron reserve until it ends at the Tanganyika–Kenya frontier. The southern boundary to commence near Nassa on Lake Victoria, thence to run east and slightly south, but north of Maswa and south of Ngorongoro crater to a point 10 miles south-east of the crater, thence north along the east border of Lake Natron reserve until it ends at the Tanganyika–Kenya frontier. The exact delineation could be arrived at only after suitable government survey.

The great plains included in this area consist in the main of undulating country with vast open spaces covered in grass and scattered patches of acacia. They lie at an altitude of from 1500 to 2000 feet. Traversing the area from east to west are the Mumusi and Mbalageti rivers, which flow into Lake Victoria. At the north-east end is Lake Natron, about 220 square miles in expanse, containing brackish water and alkaline deposits. Its eastern part is composed of volcanic lava and tuffs. The west part in the main consists of granite rocks in which are quartz reefs containing traces of gold. Its south-east area is a region of giant craters, some of which are of vast dimensions, particularly that of Ngorongoro, which is more than 12 miles in diameter.

There are several reasons why this large area is specially suitable for a national park. It would shelter an assemblage of the common plains game of Africa in an abundance and variety unequalled in any part of the continent. The chief species are elephant (a few), rhinoceros, hippopotamus, buffalo, giraffe, eland, roan (a few), topi, waterbuck, impala, Grant's gazelle, Thomson's gazelle, dikdik, hartebeest, wildebeest, bushbuck, reedbuck, zebra, lions (very numerous). These animals in certain favoured spots occur in such a teeming mass that motors driving across the plains have at times to slow up. They form a true picture of the old unspoilt Africa and provide a spectacle of zoological interest that surpasses anything of its kind in the world. Moreover, since the plains are open and spacious and covered with short grass, there is a free view of the animal herds over long distances and in all directions. Also, since the

district is easily accessible and enjoys from mid-August to mid-December an excellent climate, there can be little doubt that, with the increasing facilities of travel, it would grow into a great world attraction surpassing even that of the Kruger National Park of the Transvaal or the famous Yellowstone Park of America.

It contains very few cultivating natives. Roaming over the east portion of it however are cattle-raising Masai. But since they neither kill animals nor cultivate the soil their presence in a park should not cause serious difficulty. The area offers no possibilities of cultivation, nor is there any hope of it proving attractive to European settlers. No minerals of economic value are known in it. The soda deposits of Lake Natron have been examined with results unfavourable to their exploitation. There are certain gold reefs in the west that might turn out valuable, but the boundaries have been drawn so as to exclude them. The area contains an abundance of animal food supply and a sufficiency of salt. At certain seasons of the year vast herds of animals are forced westward for water to Lake Victoria. Hence it is essential that the west boundary of the park should include at least 40 miles of shore-line. Another fact in its favour is that it would naturally protect the three least common game mammals of Tanganyika, namely the lesser kudu, the gerenuk, and the fringe-eared oryx. Also it would be continuous across the border with the present southern game reserve of Kenya, and this, through providing a still larger uninterrupted sanctuary, would favour animal conservation.

There is no other area in Tanganyika which offers anything approaching this combination of advantages for the establishment of a national park. Both as a sanctuary for the conservation of the plains game of Africa and for providing a world attraction for visitors it comes very near to the complete ideal.

5. *Kilimanjaro National Park.*—The mass of Kilimanjaro above the lower level of the forest belt is at present a game reserve. It is proposed that this area be raised to the national park status. Kilimanjaro is the highest mountain in Africa, situated 3 degrees south of the equator. Its sides are clothed in belts of vegetation: grass and bush at the extreme base, then tropical rain-forest, then temperate vegetation, then alpine meadow, then rocky desert with lichen. Above this are bare fields of lava with névé cap and divergent glaciers. The richness and variety of this vegetation is remarkable, varying as it does from that of the tropics to the arctic. Its most striking element is the giant lobelia and groundsel, which are distinctive of the high mountain flora of Africa. The fauna too is peculiarly interesting; both the elephant and eland ascend its slopes to the farthest limit of the higher plant life. To geographers, geologists, zoologists, and botanists it is a mountain of surpassing interest.

Economically it would appear to be valueless. There is no traffic in it. Mineralogically it is unproductive. It offers no possibility of cultivation or settlement. Its creation into a national park would not interfere with any native activity or subsistence. The absolute protection of the Kilimanjaro forests implied under the status of a national park would be advantageous to the agriculture and civilization of the Wachaga and to the plantations of the European settlers who live on the lower slopes of the mountain. Mr. Gillman has pointed out that the function of the forest is to condense vapour from the trade wind, store the moisture in its sponge-like humus, and discharge the rich

stores to feed the streams. It is the forest which forms the life-giving reservoir that maintains the cultivation at the base of the mountain. Mr. Gillman regards it as the duty of the administrator that this life-giving forest "must not be touched" in the interest of both European and native alike. There is no easier way of giving effect to that policy than by converting the area into a national park.

6. *Kenya National Park.*—The area in Kenya that will prove most suitable for a national park is the present Northern Game Reserve. It is a somewhat quadrilateral-shaped expanse of territory lying to the south-east of Lake Rudolf. Its northern boundary runs from Lolajonga, 17 miles south-west of Marsabit, to Nyiro, 21 miles south-east of Lake Rudolf. Its western boundary runs from Nyiro to Pakna, 20 miles north of Baringo. Its southern boundary runs from Pakna to Koitorgor close to where the river Siolo enters the Uaso Nyiro. The total area is approximately 12,000 square miles.

It is in the main hilly country rising to elevations of from 1200 to 2000 feet and covered with either open or thick bush. Large stretches of it however are undulating and bare. On the east it includes the Mathews Range, difficult of access, almost uninhabited, and one of the most perfect elephant sanctuaries imaginable. On the west it is in places precipitous and impassable owing to lava brakes and gorges. On the south it is traversed by several streams which flow into the Uaso Nyiro. If it is decided to establish a national park in this area certain adjustments of boundary would be advisable. The Lorogi plateau in the south-west contains little animal life and might well be excluded from the area, while Mount Marsabit to the north-east, where game is both abundant and of peculiar interest, might with advantage be included. The Mount Marsabit region is a crater system with plentiful water supply and magnificent forest. It is an important elephant focus in the dry season.

Game is plentiful over large areas of the Northern Reserve. It is of particular value as a breeding ground for elephants, especially the Mathews Range and Mount Nyiro. The rhinoceros is present in fair numbers. The buffalo is plentiful both in the reserve and the forest round Mount Marsabit. Though many of the giraffe have been killed by Abyssinians, yet they are still fairly numerous. Grant's zebra is plentiful in certain parts and the much rarer Grevy's zebra exists in fair numbers. Waterbuck occur in the wet areas; reedbuck on the hills; bushbuck in the scrub and forest tracts; there are a few oribi and possibly some roan. The greater kudu and gerenuk are found on Mount Marsabit. Oryx, eland, lesser kudu, hartebeest, impala, Grant's gazelle, Waller's gazelle, klipspringer, steinbuck would all find efficient sanctuary. The lion, leopard, and cheetah are fairly plentiful throughout. The grazing is good and water supply sufficient.

There is little doubt that this area will prove the most suitable for a Kenya national park. An alternative site of possible value lies in the little-known desert region north of the Athi river east and west of Tsavo. But as this region has not yet been fully explored I will not dwell on it in this paper.

7. *Bongo National Park.*—It is advisable that a permanent sanctuary be established for the protection of the bongo, a reclusive, forest-dwelling species and one of the rarest of the African antelopes. An eminently suitable locality would be the forested slopes of the Aberdare mountains north-west of Nairobi.

The proposed area lies between the Uplands–Naivasha road and the Njabini–Karuri's Boma track, bounded on the east by the Kinangop farms and on the west by the Kikuyu reserve. This area is at present forest reserve. It is a matter of economic importance that the primeval forest of this area should remain in its unaltered state. It is the collecting reservoir for the several rivers that feed the Kikuyu reserve and supply the coffee-producing districts with water. Its mammalian fauna, in addition to the bongo, contain many interesting forms. There are in it elephant, buffalo, bongo, bushbuck, waterbuck, red duiker, colobus monkey, Sykes monkey, baboons, giant forest hog, bush pig, leopard, serval cat, gennet, and hyrax.

8. *Bunyoro-Gulu National Park.*—The most suitable area in Uganda for a national park is that which is now designated the Bunyoro-Gulu Game Reserve. It is a somewhat quadrilateral-shaped area of 1793 square miles on either side of the Victoria Nile, from Lake Albert on the west to Foweira on the east. It contains almost every variety of country, such as bush, grassland, swamp, ravine, patches of thick forest and open areas offering a free view of the animal life. The most striking geographical feature in it is the well-known Murchison Falls. The scenery of the area is very magnificent, and has been well described by the game warden as "one of the finest spectacles of wild unspoilt Africa which yet remains."

Several reasons make it eminently suitable for converting into a national park. It contains a splendid assemblage of wild animals and is the home and refuge of thousands of elephants. Where there is broken bush the rhinoceros occurs. Hippopotami abound in the pools, in the tributary streams, and in the Victoria Nile. Both buffalo and giraffe occur but are scarce. It possibly contains a few eland. In the area north of the Nile there are some roan antelope. Waterbuck are common everywhere. Reedbuck are numerous along the rivers. Hartebeest and kob are abundant, harnessed bushbuck fairly plentiful, and oribi well distributed throughout. Lions, and no doubt the other common carnivora, are spread through it in fair numbers. One of the sights on this section of the Nile is the incredible numbers of crocodiles, which literally heap themselves along its banks. It contains very few human inhabitants, the only ones being a small fishing community on Lake Albert between Kigoya and Ndandamire. It offers no possibility of cultivation nor any likelihood of European settlement. Geologically it has not been thoroughly explored, but there is no reason to think that it contains anything of mineral value. From the point of view of tourist attraction it offers large possibilities. Its scenery is magnificent and the Murchison Falls an attraction in themselves. Indeed, it is already a place advertised by the railway authorities as a goal for the African tourist. Being on the route of the Nile traffic it is accessible, and it is probable that a railway will run through it in the future. If it were labelled a national park, a term which has a world-wide significance and meaning, there is little doubt that visitors would be drawn to it in considerably increasing numbers.

9. *The Gorilla National Park.*—On 2 March 1925 His Majesty the King of the Belgians, created by Royal Decree the Parc National Albert in the Kivu District of the Belgian Congo. The park was enlarged by a later decree in May 1929 and now consists of 500,000 acres divided into four reserves. The

chief object in view in the creation of this park was the protection of the mountain gorilla. Within the area it is forbidden under heavy penalty (1) to pursue, capture, kill, or molest any kind of wild animal, including animals which are reputed dangerous or harmful; (2) to take or destroy the eggs or nests of wild birds; (3) to cut down, destroy, or remove any cultivated plant; or (4) to make any excavation, embankment, boring, or any operation of a nature to change the aspect of the ground or the vegetation. The park is administered by a Commission consisting of not less than eighteen members: one-third, including the President, to be appointed by the King, another third to be selected by the King from nominations made by Belgian scientific institutions, and another third to be chosen from foreign scientific institutions. The liberality which permits the association of foreign scientists in the control of the Parc National Albert is an important step towards that international co-operation which is so helpful in preserving the wild life of Africa.

The extreme south-west portion of Uganda forms an angular projection into Congo territory, the three peaks Sabinio, Mgahingi, and Muhavura standing on the international frontier. The southern slopes of these peaks are on the Congo side and form part of the Parc National Albert. The northern slopes belong to Uganda, and on these slopes is found the gorilla. The proposal is that the Uganda slopes of these mountains, limited by a line roughly along the foothills, be constituted a national park. The whole of the mountains on both sides of the frontier would then have the status of a permanent sanctuary. The object in view is the preservation of the gorilla throughout the whole area of its distribution. At present the area is a proclaimed sanctuary and the gorilla is in no danger of immediate molestation; but a sanctuary on so insecure a basis does not offer that guarantee of permanency which is essential for perpetual preservation. The gorilla, after man, is the most interesting animal in the world. This mountain species is inoffensive and the natives of the region have no fear of it. It inhabits the mountains up to 10,000 feet, living in the bamboo forest and giant heather, where it is very difficult to see. Probably about one hundred gorillas live within Uganda limits, but whether they are permanent residents or seasonal immigrants is still an unsettled question.

The area involved in this proposal occupies approximately 17 square miles. It offers no possibility of cultivation or settlement and is composed exclusively of volcanic rock of no mineral value. It is sparsely inhabited by Batwa natives, a dwarfed race which live exclusively by hunting. The killing of animals is necessary for their existence, and this of course is opposed to the fundamental principle implied in the status of a national park. The Batwa cannot be restricted in their habitation of the area nor can their hunting habits be interfered with. Fortunately they do not hunt the gorilla nor molest it in any way nor eat its flesh. Under such circumstances it will be necessary to modify the park regulations. Though maintaining the usual restrictions on visitors from outside, suitable modifications will be necessary in order to permit the Batwa to continue hunting with their primitive weapons only. This proposal of a national park for the gorilla is based exclusively on the importance of preserving this species. The region offers no attraction for visitors and is likely to be inaccessible for many years.

Management of National Parks

A national park, having been made the property of the public for ever, is best controlled by a public committee elected from persons in the territory interested in wild life. The government should be represented on the committee. In East African territories the chairman of the committee would preferably be the Game Warden, a second member might be appointed by the Governor direct, another by the Planters' Association, another by the Chamber of Commerce, another by whatever was considered to be the next most important unofficial body in the country. In the case of native reserves the control is in certain circumstances vested in the Secretary of State. It is inadvisable that this procedure should be followed in the case of the national park, the reason being that when the control is vested in the public there is more likely to develop a public pride and interest in the park than if the control is vested in the Secretary of State. The park will be managed by a resident staff, who will control the conservation of the fauna and flora, the direction and guidance of the visiting public, the upkeep of roads, buildings, bridges, and means of locomotion within the park area.

It is the ideal that in a national park every feature should be left in the primitive state of nature. But this ideal cannot be reached under the conditions existing in Africa. We can scarcely expect the prohibition of all mining claims, the prevention of all grazing by natives, or the complete exclusion of every type of human settlement from the park area. Furthermore, Nature will have to be interfered with in order to provide the access and amenities required by the visiting public. But the guiding rule will be to interfere only when necessity demands. Regulations will be required to prevent visitors from hunting, killing, capturing, or frightening any species of wild mammal or other form of animal life. The carrying of firearms must be prohibited except for purposes of protection after sanction by the park authorities. Fishing with nets or traps or lines should be disallowed. Visitors must not be permitted to destroy, injure, or disturb trees, flowers, vegetation, rocks, or minerals, or dig in the ground of the park. Camping has to be prohibited except at recognized camping-sites. Suitable instructions may have to be issued that fires shall not be kindled near trees, dead wood, moss, or other form of combustible refuse. In Africa it is likely that camp fires might become one of the chief perils in a park.

Should a park become a source of interest to the public and tourist traffic begin to develop, then the entrance fees collected from the visiting public will be available for the improvement of the park. The making of roads, trails, rest-houses, hotels, camps, sanitary conveniences, the bridging of rivers, the development of means of transport, etc., can be undertaken in proportion to the number of visitors. Special efforts will be necessary to make some parks healthy. Drainage in the vicinity of camp sites and advice on the usual personal precautions will be required in malarious regions. Tsetse fly offer greater difficulties. Their presence may influence the lines selected for roads, and it may be found advisable in places to clear away bush. Prophylactic inoculation against sleeping-sickness may have to be considered.

Although visitors must be prohibited from interfering with the natural features or life of the area, it is certain that the resident staff will at times have

to interfere very ruthlessly. Yet their efforts will be guided by the great aim to do the least possible violence to Nature as is compatible with man's enjoyment of the park. For instance, it may be advisable in arid areas to sink water-holes or construct dams or otherwise improve the water supply for animals. Through absence of rain there may be a shortage of fodder, and this may demand an artificial thinning of the herds, though as a general rule it will be found better to allow Nature to work unchecked. Man will thin with little discrimination; Nature will weed out the old, sickly, and weak. Carnivores may at times increase unduly or their numbers will remain disproportionately large when famine reduces the stock of herbivores. Lions, leopards, wild dogs, and hyenas may then have to be thinned by shooting or trapping, especially as they are liable to attack man and his stock when their normal food supply begins to grow scarce. It ought to be regarded as a general principle that exotic species must not be introduced. The park is intended to preserve Nature's work in its particular area only.

Much of the attention of the resident staff is likely to be directed to the activities of poachers. People will enter on various pretexts—to look for minerals or to take photographs—when what they really are after is an easy shoot. The boundary of the park may give rise to difficulty. It is not intended that these immense areas should be limited by any kind of fencing. The natural increase within the park area should find a free overflow across the boundary. Once over the boundary the animals can be shot in accordance with the game regulations of the country. It is clear, therefore, that the time will come when these sanctuaries may not only hold the last remnant of wild life, but will provide through overflow across their boundaries the one remaining resort for the sportsman. The problem of the boundary has been solved ingeniously in the Kruger National Park of the Transvaal. A buffer area has been formed along the border consisting either of unoccupied land or of farms sold or let to sportsmen. This arrangement is doubly advantageous. The sporting section of the public are given means of enjoyment; the park authorities are relieved of the complaints which would occur if settlement or cultivation were on the boundaries of the park. Indeed, on all matters relating to parks in Africa we must turn first to the Kruger National Park of the Transvaal, and especially to the wisdom and experience of its founder, Lieut.-Colonel J. Stevenson Hamilton.

Economic Value of National Parks

I do not hold the view that the conservation of wild life should be based solely on financial gain. I maintain that all creation is man's heritage and that posterity will condemn us if we squander it. But we have every right to make full use of that heritage and secure from it the greatest advantage, provided we do not fritter it away. We have at present in the wild life of Africa an important revenue-producing commodity. The sale of ivory, rhinoceros horn, and hippopotamus teeth is throughout the British possessions of East Africa practically a Government monopoly. Revenue is also obtained from licence fees, from import duties on guns and ammunition, and in some territories from export duties on trophies. Then the game supplies much indirect revenue from duties on the various articles of equipment brought into the country by visiting

sportsmen. During the year 1928 the wild life brought in a direct revenue to Kenya and Uganda amounting to £41,480.

This revenue is essentially a revenue from destruction, being derived exclusively from killing the game. Moreover, as a result of killing it is an asset that is steadily diminishing. Fortunately the world appears to be changing. A feeling is growing up antagonistic to shooting. The cinema is slowly taking the place of the rifle; the film is being regarded as a finer trophy than the horns; people are beginning to watch wild life without being filled with the lust to destroy it. There is little doubt that in the future the revenue from wild life will depend less on shooting and hunting and more on displaying animals for observation in large national parks. In this respect the splendid material of East Africa is still almost completely unexploited.

There is not the slightest doubt that these unique animal assemblages provide a highly remarkable spectacle of the deepest interest to the world at large. The Zoological Gardens of London are the biggest draw in Britain, and as a spectacle they cannot compare with vast plains covered with myriads of wild beasts. Material exists in Africa which, if properly exploited, might be converted into a sight-seeing attraction which would surpass anything of its kind in the world. We must not forget how rapidly distances are shrinking, and that the next generation will visit Central Africa as easily as the present one visits Switzerland. The attraction is there, but the world must be told of it. At first the return will not be great, but in the end it will undoubtedly be substantial.

The experience of other countries has demonstrated that the national park can be made a source of considerable revenue. The national parks of the United States come first in this respect. The number of visitors to the institutions administered by the National Parks Service increased from 356,097 in 1916 to 3,024,844 in 1928. During 1916 they brought in a revenue from all sources which amounted to $177,470·69. In 1928 this figure had increased to $808,251·81, and these funds were turned into the treasury to be made available for purposes of government. During 1926 the number of visitors to the national parks of Canada was 333,397, including about 20,000 from overseas. This last figure shows the power of a national park to attract the public of another continent. The revenue of the new Kruger National Park in the Transvaal amounted in 1930 to about £3500. We must not forget that the very name "National Park" is one of no small significance. The name "Reserve," as applied to the present African sanctuary, has in this connection no meaning. It might be a native reserve or a mineral reserve or a forest reserve or a game reserve. To the outside public it has no significance. But the term "National Park" has a world-wide meaning and brings to mind such famous institutions as the Yellowstone Park of the United States or the Kruger National Park of the Transvaal.

What the public will require in these zoological parks is the sight of large herds of spectacular animals at close quarters and comparatively tame. Moreover, they must be seen without difficulty and with a reasonable degree of comfort. The public is not likely to care much about rare or scattered species. The African mammals go mainly in herds and many of them are highly spectacular. The giraffe and the zebra are peculiarly decorative and certain to arouse great admiration. The wildebeest, though not attractive through its colours, will

excite interest by its odd appearance and antics. The gazelles are certain to be admired from their gracefulness and the impala from its remarkable habits of leaping. The visitor will be in a ceaseless state of expectation in the hope of seeing an elephant, rhinoceros, or lion or other awe-inspiring creature. It is well known that the animals within a sanctuary become tame very rapidly. In the Kruger National Park lions take scarcely any notice of motor cars, sometimes even refusing to get up from a road in order to let the car pass. Wildebeest and zebra and other herds, after a few years of complete freedom from molestation, will permit approach to close quarters. All this favours the enjoyment of visitors and opens wide opportunities for animal photography, which should be encouraged within a national park.

A national park may have other important uses. It will have a distinct educational value, and no better locality could be imagined for an institute of tsetse fly or zoological research. Any excess or overflow from the park would become the source of supply for the zoological gardens of Europe and America, and this would bring in additional revenue. Nor have we by any means fully explored the practical utility of these different animals. We have not yet properly tried the experiment of domesticating buffalo and eland, and thus adding to the meat supply of the world. The domestication of the African elephant is in its infancy, though the Belgians have demonstrated that it can be tamed with the same facility as the Indian species and usefully employed for the same kinds of labour. Nor must we forget that these herds of game animals have developed an immunity against tsetse-borne diseases, and though people sometimes condemn them as a menace, yet the time may well come when we shall look to them for the serum that will purify us from the terrible scourge of trypanosome.

The Future of the Wild Life of Africa

What of the future? For myself, I believe that the one great hope lies in converting the living animal into a commercial asset. There is little good in appealing to sentiment and duty. Admittedly when a species is bordering on extinction, as the gorilla in the Congo or the white rhinoceros on the Nile, then serious action will be taken to save it, but even then only if the saving demands no important material sacrifice. Mankind will not preserve the wild life of the world, or at least only to an infinitesimal extent, if he is going to lose materially thereby. This has been the story in America and South Africa, and it is likely to be the same everywhere. Probably this view would not be generally accepted. The subject is highly controversial, and there are persons who are perfectly satisfied that the wild life of Africa is in complete safety. But what has happened in our own continent? It is only since the war, within the last twelve years, that the last European bison was exterminated in the wild state. When we see the largest and most notable animal in our own continent annihilated before our eyes without protest, surely it is idle to pretend that any species is safe in the remote tracts of other continents. The blaubok, the quagga, Burchell's zebra, and the white rhinoceros only too surely point out the road that the wild life of Africa is following.

It is, unfortunately, the huge and extraordinary pachyderms which stand in the greatest danger. In our lifetime the white rhinoceros covered half a con-

tinent; to-day there are twenty individuals in Zululand and 130 individuals in Northern Uganda. What chance have they of surviving? Even if not another single individual were killed, is there any hope that a wild stock so terribly reduced will not grow decadent through inbreeding and disappear? The elephant has gone down at a stupendous rate, and can any one anticipate its long survival when one-tenth of the whole elephant population is removed annually from the African continent? The black rhinoceros is vanishing fast in order that its horns may be sold in China to satisfy a filthy trade in aphrodisiacs. The hippopotamus is following on the same road, and it is probable that in another twenty years it will be eradicated from most of the rivers of Africa. Many other species are a cause for grave concern. The gorilla, Grevy's zebra, roan antelope, nyala, eland, oribi, sable, kudu are all greatly reduced in numbers and are steadily on the downward path. The wild life of Africa cannot possibly withstand the several forces that are driving it from the world. It has retreated in the past, and the retreat will continue more rapidly in the future. The one hope of saving a fragment is to give the wild life a permanent compartment altogether away from man's interference. And the main hope of keeping the compartment inviolate is by converting it into a financial asset.

There are certain things we can never protect against. We can tie up land by Act of Parliament, but we cannot prevent posterity from repealing that Act, and is it likely that the Act would not be repealed if the land could be put to some more remunerative use? We can never protect against wars and insurrections, and nothing but harm can come to parks and sanctuaries in the unknown future strifes of Africa. A war or rising may sweep into oblivion half a century of labour in the cause of protection. Nor do we really know what will happen to great herds of animals as a result of their being restricted over long periods within confined geographical limits. We have little to go on. Certainly if the stock happens to be small at the beginning there will follow a degeneration as a consequence of inbreeding, such as has occurred amongst the buffalo of the Yellowstone Park, and degeneration is only a stepping-stone to extinction. Nor is it likely that we can ever deal with those fearful epidemics which at intervals sweep through the African herds. They are likely to be still more terrible in a thickly populated park, and it is the belief of some of the best authorities that a wave of rinderpest under such circumstances might totally extirpate a species.

The future is therefore full of difficulty and fraught with the gravest danger to wild life. It is deplorable to have to look to material motives for the preservation of this grand imperial possession. Its disappearance would be a tragedy and a disgrace, and a crime against future generations. Dean Inge has put it on a higher level and sternly rebukes the evil forces of destruction. "With our wide Empire," he writes, "we can do more than any other nation to protect animal life; and we may be quite sure of this, that if our legislators will have the courage to deal firmly with this evil, disregarding the protests of a small number of interested persons, they will be considered by future ages to have taken a step forward in civilization and to have thereby brought honour to their country."

DISCUSSION

Before the paper the PRESIDENT (Admiral Sir WILLIAM GOODENOUGH) said: Major Hingston's versatility in geographical and kindred investigations has been well shown. He acted as medical officer to the Survey of India party that completed the junction of the Indian triangulation with that of Russian Turkistan. After seeing a considerable amount of service in East Africa and 'Iraq during the war, he was for some time naturalist in the Indian Marine. In 1924 he was surgeon and naturalist to the third Mount Everest Expedition, and distinguished himself by his care and skill when Colonel Norton was brought down snow-blind from the North Col to Camp III. Since his retirement from service in India he has devoted himself to a series of expeditions in which his interest in geography and in natural history are combined, and I am sure that many here will remember the account he gave of his leadership of the Oxford University expedition to British Guiana. He has recently returned from a journey through South and East Africa on behalf of the Society for the Preservation of the Fauna of the Empire, and it is the geographical aspect of that expedition which he will describe to us to-night.

Major Hingston then read the paper printed above, and a discussion followed.

The PRESIDENT: To his very great regret the Belgian Ambassador, who would have been here to-night, is incapacitated by influenza, but he is very well represented here by Prince Reginald de Croy. Prince Reginald tells me that he is not really fitted to speak on this subject, but I venture to disagree with him, and I will ask him to say something to us.

PRINCE REGINALD DE CROY: I want to express the Ambassador's deep regret at not being able to come here to-night. He asked me to say that it was the keenest disappointment to him. For many years he has taken a great interest in this particular question and, had he been here to-night, I am sure he would have been able to add a few interesting remarks upon it. The creation of National Parks has been a matter of great interest in Belgium for many years past. At the instance of and with the encouragement of our Sovereign, King Albert, a certain amount has been done already in establishing the Parc National Albert, a favourable account of which I was glad to hear to-night from Major Hingston. There is still much more to be done, and, after listening to this most interesting lecture, one cannot but feel the gravest apprehension for the future of many of the most interesting species now in Africa. I know it is the wish of those in Belgium who take an interest in this matter that other National Parks should be established, and I have no doubt that that will come about in time. If the movement for the creation of such Parks is a success in England, the Belgian people will be greatly encouraged. Indeed, nothing will encourage our people so much as the knowledge that other countries are favourable to the idea. I can assure you that if the collaboration of the Belgian authorities can in any way assist the movement you can count upon it in every way.

Sir ALBERT KITSON: I wish to make a few remarks on this matter, because it is one which has interested me for many years. With the greatest pleasure I have listened to the admirable manner in which Major Hingston has presented the paper. It is regrettable that the author's observations do not include the three British colonies in West Africa—Nigeria, the Gold Coast, and Sierra Leone. It would give me particular pleasure to see something similar done with regard to those three colonies. People who have travelled through West Africa know well that Major Hingston is correct in saying that the destruction of so much big game is not due to the good type of sportsman, but to the methods of native hunters.

In addition to their indiscriminate shooting they destroy animals in various ways. I have seen in Nigeria pits similar to those that Major Hingston described and have fallen into one, fortunately without a stake in it. Many of them have stakes and are so cleverly covered on the surface that the unfortunate animals fall into them and get trapped. Some of the pits are large enough for elephants. In other cases strips of liana are put over game tracks. To these are attached logs with sharp spears in them, and suspended over the tracks. Animals when going along the tracks trip over the cords, thus releasing the heavy logs, which fall and impale the beasts in their backs. It seems to me that we should do the best we can to support this movement for establishing permanent reservations for animals of this kind. Let us do what our lecturer has advocated—urge that such reserves should, by Legislative Acts, be made National Parks, not simply reserves. In the latter case circumstances may result in a bit of land being taken for one purpose and a bit for another, and before long the whole of it has gone. Let us do what America and Canada have done. Those who have been to the Canadian National Park in Western Alberta know well how trustful some of the wild animals are. When one is motoring along the road brown bears amble out of the forest, stand by the car and beg. After having been fed with buns, fruit, or sweets, they amble back into the forest.

But in order to preserve the animals in these big areas in Africa stringent regulations should be made and enforced to prevent the annual burning of grass. This burning of grass means that numbers of forms of animal life and enormous numbers of plants are destroyed, the surface of the ground is bared, and becomes unprotected by vegetation, so that from sloping ground tropical rains continually wash away soil that has been derived from the underlying rocks by decay of rock-forming minerals and disintegration. Especially is this so with regard to those of crystalline character, as granites, and sediments, as sandstone. Thick vegetation on a soil is a great protection to it, and in three or four years, with the cessation of burning, a young forest will appear, as can be seen in the Gold Coast. This would eventually become a thick forest of large trees and undergrowth. On the Gold Coast the Government has set apart a fairly large area of that comparatively small colony as a game reserve. That reserve is in country which becomes waterless over large portions in the dry season, as most of the streams then cease to flow. Native hunters burn the grass annually and thousands of seedlings and small trees are burnt. Nevertheless, in portions of that country there are small patches of thick forest that have escaped destruction. They show that the whole country was at one time covered with a thick forest, and can again become so.

If a National Park be established with effective protection the whole of it will, in due course, be covered with good forest, forming shelter for animals, birds, etc., and suitable conditions for natural conservation of water.

The PRESIDENT: I had hoped that Lord Onslow, who is President of the Society for the Protection of the Fauna of the Empire, would have been here this evening, but he is still abroad. However, Mr. Hobley, the Secretary of the Society, is present, and I will ask him to speak.

Mr. C. W. HOBLEY: I should like to congratulate Major Hingston on the able and lucid address which we have heard to-night. There may be some critical people who may ask what this has to do with geography. Those who think a little more deeply however no doubt take a more catholic view and will agree that the study of wild animals and of tree and plant life is part of a greater geography, which in a general way embraces people, animals, and plant life, and therefore we are justified in considering the distribution of the beautiful animals in Africa and their preservation as part of the geography of the country.

I think that the British race is, above all others, the most sympathetic with regard to wild animals and animal life. When the question of preventing cruelty to animals arises, no people are so indignant as those of British stock. Then again, I would venture to mention that in this city of ours there are over 2,000,000 people who annually visit the Zoo, and I take it that they go there mainly to see the beautiful creatures which are shown in the gardens. That alone demonstrates an active interest in wild life, but it is not active enough. It is an activity that wants to be directed and converged in certain directions. I believe there are people in this audience who would willingly risk their lives to save the life of a dog. If at the same time many of those read in the daily press, about a year ago, that 30,000 beautiful wild animals had been slaughtered in a certain part of Africa in a vain endeavour to check the activities of a disease-carrying fly—I will not criticize it, but it is a fact—they would feel a pang, but the feeling would not last. The incident is too far away. Next morning another startling news item appears and they would forget all about the slaughter of those animals. I want to bring this sort of thing more strongly before your minds and make it more real.

Major Hingston has told us about the difficulties of the case, and the difficulties must not be minimized. There is civilization and the relentless business called progress. If you could call the animals of Africa into council and say to them, "My friends, do not go and eat the settlers' crops, because if you do you will be in for trouble," an agreement might be reached which would be all to the good, but of course you cannot do that, and all the time economic progress pursues its relentless course. But this proposal to set up National Parks is a measure of practical politics and can be carried out without interfering with the progress of a colony, the interests of the colonists, and not least, those of the indigenous natives. We believe it is a policy of vital importance. Public opinion in England is a great factor, and we see its influence in many directions. We want more of it. We want a greater weight of public opinion exerted in favour of this scheme which is one of great national importance, and I will even say of great international importance: it will be a great thing to safeguard the perpetuation of these assemblages of wild life, and future generations will look back and say, "How wise these people were!"

The PRESIDENT: Any one connected with this institution will know the name of Colonel Stevenson Hamilton. He is on his way back to Africa and not able to be here, but he has written a memorandum on the subject, a small part of which, as it is rather late, I will ask the Secretary to read to you.

The SECRETARY thereupon read extracts from the following memorandum by Colonel Stevenson Hamilton (Warden of the Kruger National Park): The Kruger National Park evolved from the Sabi Game Reserve, which has the distinction of having been the first wild-life sanctuary ever declared on the African continent; it was proclaimed as such by the Transvaal Republican Government in the early part of 1898. In 1898 the Sabi Reserve contained only some 1500 square miles of territory, but after the conclusion of the South African War in 1902 the Crown Colony Government added large unoccupied areas, so that by the end of 1903 the Reserve consisted of over 14,000 square miles. It was in 1902 that special regulations were first framed and a white and native staff appointed. In those days the wild animals were scarce and very wild, due to many years of unrestricted persecution, but a nucleus of all indigenous types remained, and freed from pursuit by man they rapidly increased and spread into areas from which they had been absent for a long time.

In 1926 the South African Parliament unanimously passed the National Parks Act, by which the Sabi Reserve became the Kruger National Park safeguarded

from violation without the sanction of both Houses of Parliament. All private rights previously existing were expropriated, and the Park was placed under a Board of Control responsible to the Minister of Lands, but otherwise with a free hand to run the Park to the best advantage. The first task of the Board was to popularize the Park by giving easy facilities to the public in the way of motor roads, rest camps, etc. It was realized that the only method by which the permanence of wild life in a sanctuary can be guaranteed is by making the scheme popular with the general public.

Areas in which wild life is protected may be divided into three grades: (1) The Preserve, in which wild animals are protected from all except a limited number of favoured individuals; this method is unpopular according to present-day ideals. (2) The Reserve, an area in which wild animals are protected entirely and in which no shooting is allowed, but which affords no facilities to the public and considers only the preservation of the animals. Existing in virtue of a simple government proclamation a Reserve is open to attacks from every side. The public is unsympathetic and sooner or later one interest or another opposed to its principle will get the ear of the powers that be, and it will be abolished. (3) The National Park, which is the logical goal of a Reserve, and is not only protected by being on the Statute Book of the country but rests securely on the goodwill of a sympathetic public. Some local town public is however essential to a National Park, and at present South Africa alone on the continent possesses such an asset. The countryman in Africa is a settler or farmer, and, even if sympathetic to wild life preservation generally, he is generally so well accustomed to wild animals, so to speak, in his back yard, that he has no desire to go and look at them in a special sanctuary. To the townsman, on the other hand, all the conditions and sights are new, exciting, and delightful, and he returns to his office full of enthusiasm for this new form of holiday, of which he takes care to spread the joys throughout the circle of his acquaintance. Thus I think it is on the town rather than on the country public that we must ultimately depend for the success of such institutions as National Parks until indeed the day comes when outside these Parks all wild life shall have disappeared in its larger forms.

The Park was first opened to the public in 1928. In that year 200 motor cars paid the entrance fee of £1 per vehicle. In 1929 the number rose to 800, and last year (1930) 3000 cars and lorries entered the Park. There have been about 500 miles of fair motor road made—what are known as "dirt tracks," of course, but hard and good for six months of the year. The various permanent rivers are crossed by pontoons capable of bearing vehicles up to 3 tons in weight; a fee is charged for each car crossing. There are eight Rest Camps, each consisting of a number of concrete huts. Light, fuel, hot and cold water, and attendance are provided, together with a bedstead, for 2*s*. 6*d*. per night per head; but food and bedding are extras. There are a number of regulations made with a view to sustaining the amenities of the Park and for the benefit of the public itself, and these have to be observed under penalty. Guide books, maps, and all details as to the Regulations may be obtained from the Secretary of the National Parks Board, Pretoria, who is always willing to give the utmost assistance and information to intending visitors. Maps and guide books as well as refreshments may also be obtained from the gate-keepers at the five entrances to the Park. All entrance fees are paid at the gates.

The Park itself is just under 9000 square miles in extent, being a strip of the Transvaal adjoining Portuguese East Africa, some 210 miles long by about 40 miles wide. The climate is excellent for half the year, but hot and malarious for the other half. Accordingly it is open to the public only during the healthy months, that is, from May 15 to November 14, with the exception of a small area

in the western portion, which is available for day trips only, during the bad weather.

The number of wild animals is hard to calculate, but is probably in the neighbourhood of half a million. This includes a herd of about a hundred elephants and numerous giraffe, buffalo, and hippopotami. Rhinoceros are scarce. Lions are in due proportion to the game; in 1925 the number was estimated at 500, and since then there has no doubt been a considerable increase in the total, for since the inception of the Park, the staff have only killed such individual animals as have developed criminal tendencies, by breaking out of the Park to attack the cattle of farmers and natives, instead of sticking to a diet of wildebeest and waterbuck.

What immediately strikes the visitor to the Kruger National Park is the amazing tameness of all the animals, and the complete unconcern they display to the passing of motor cars. No shooting having taken place for nearly thirty years the present generation knows nothing of firearms, but innate suspicion prompts the animals not to permit a human being to approach to a distance less than 50 yards. With that space between the animals feel safe and do not take much notice, but, accustomed to their natural enemies, they do not trust themselves nearer than the above distance from foot passengers. With cars it is different; neither game nor lions seem yet to associate the human element with an automobile, and often animals lying close to the road do not even trouble to get up. This is often awkward in the case of lions. It sometimes happens that visitors find the road in front occupied by a troop of eight or ten lions of all ages sunning themselves and entirely disinclined to move out of the way. The animals show no hostility whatever, but merely absolutely decline to be disturbed or to take any notice whatever of the hooter or the shouts of the tourists. If the driver has the nerve to go straight on in low gear the animals will lazily get up and move out of the road when the car is almost on top of them, but usually visitors reverse the engine and leave the lions in possession for the time being. I think at present lions do not associate cars with human beings at all; their keen scent tells them that cars are not good to eat, and as they appear to be quite harmless in their experience, they set them down as unknown stupid large animals of a new type entirely devoid of interest one way or another.

The growing popularity of the Kruger Park is very remarkable, and it is rapidly becoming the favourite holiday resort of all who possess cars of their own. In addition, tours by motor buses are advertised from all parts of the Union. Arrangements have been made at Lourenco Marquez for motor transport to run in connection with liners putting in at that port, so that passengers with two days to spare may be able to spend one of them among the wild animals, the Park being only 70 miles from the coast at that point. The South African Railways also run fortnightly special trains during the best three months of the year, giving passengers a day and a night in the Park.

The PRESIDENT: We have listened to some very interesting proposals and remarks made in the course of the discussion. What is it that makes it desirable, or indeed essential, to have these Parks if we are to preserve this wild life? Curiously enough, it is the advance of what I suppose is called the civilization of man. I was struck with what Sir Albert Kitson said about the brown bears in a Canadian Park, that there were 3000 motors or lorries on the roads, and that the animals were seen doing this and that, and that you fed them with buns. I am bound to own that this thought crossed my mind: is this being done for the animals or is it being done to make a sort of exaggerated show for us? My sympathies, after hearing the lecture, were with the animals, and I should feel rather inclined to hope that we do not advocate this National Park in order that the human animal may go and amuse himself by looking at the gorilla. What we

have to do, I think, is to give the animal life the first chance. It seems to me they are much the same as human beings. If we give them freedom and room to live in they live in comparative amity. If we herd them together in close spaces, for one thing they quarrel and for another they make themselves rather a nuisance.

See what Major Hingston said about the habits of the gorilla. He considered that the habits of the gorilla were the most interesting habits of any animal save man. It would appear that what makes the study of man so interesting is that his actions alone are incomprehensible.

One thing I would say before I go on, and I say it in all seriousness, and not as a joke at all. Man does want some protection. I have in my mind at this moment the case of a settler I knew when I was Commander-in-Chief in Africa. He had a certain amount of money and took a farm. He had to make up his mind as to whether he would fence his farm or develop it, and he put all his money into development. After two years he got his first crops, and those of you who have been pioneers in Africa will know what that means. Everything was all right, but a herd of animals came across and in two days swept the land clean. It was finished, and there was nothing left of two years' work. I only say this to show that it is necessary, as the lecturer said, if we are going to preserve these animals, that some segregation should take place.

With regard to these proposals, the attention with which you have received them shows that you are in sympathy with them or with something kindred to them. I understand that the Society for the Preservation of the Fauna of the Empire, of which Lord Onslow is President, will welcome applications for any further details regarding this most interesting and important subject.

In conclusion, might I offer to you, Major Hingston, the best thanks of myself and the Council of the Society for giving us some most interesting proposals and a very charming evening?

THE 45° PRISMATIC ASTROLABE: *A paper read with the following paper at the Afternoon Meeting of the Society on 19 January 1931, by*

INSTRUCTOR CAPTAIN T. Y. BAKER, R.N. (Ret.)

ANY determination of latitude and longitude by astronomical observation is a determination of the direction which the vertical at the place of observation holds relative to the fixed stars at a certain time. The observation is usually made by actual measurement of certain stars' zenith distances, or, alternatively, by noting when certain stars reach a specified zenith distance. In all cases when one is dealing with precise work it is of the highest importance to design apparatus which is as free as possible from sources of error either in the mechanical construction, or the method of adjustment, or the method of use. In looking at the problem of accurate determination of position from this standpoint it is clear that the two main sources of error lie (*a*) in the accuracy of the alleged vertical from which zenith distances are measured, and (*b*) in the measurement of the angles themselves, this latter case including that of noting the times when the various stars reach a certain specified zenith distance.

If one approaches the problem of designing *de novo* portable apparatus that will achieve the determination of position with the highest degree of precision in a minimum of time, one is obliged to decide at the outset between two quite distinct methods of setting up a reference line to represent the vertical. One can embark upon a design of the theodolite type where some mechanical axis is set up vertically, round which the instrument can turn in azimuth in order to observe different stars, and provide with this apparatus highly sensitive levels that permit of adjustment of the axis by means of levelling screws. The alternative is to make use of the vertical represented by the normal to the surface of a pool of mercury and determine the zenith distance by measurement of the angle between a star and its reflected image. The theodolite is a representation of the former case, the astrolabe, or the sextant, of the latter.

In talking of determination of position with high precision one is contemplating something that is true within one second of arc, and it is interesting to look at the meaning of one second of arc from the practical aspect both as regards levelling a theodolite and in the reliability of the surface of a pool of mercury. The theodolite is usually mounted on some sort of tripod, and no matter how carefully the instrument be made and levelled the vertical axis will only remain vertical throughout a series of observations provided the three feet of the tripod remain fixed. If one sinks ever so slightly in the ground the vertical axis will be displaced, and the amount of sinking required to produce a 1″ tilt is round about 1/5000th of an inch, roughly a fifth of the thickness of a cigarette paper. The matter is really worse than this, for in order to get inside one second on the final result one cannot tolerate a possible systematic error that is anywhere near the same amount. Wind pressure on the side of the instrument is another possible cause of displacement of the vertical axis. Even when the ground is hard and wind is negligible the levelling to inside a second is a tedious and uncertain business.

The mercury pool as a means of registering the vertical seems to have much

more to recommend it. The most satisfactory method is to use an amalgamated copper plate upon which a pool about a millimetre in depth will rest under capillary action without running off. The meniscus at the edge is of course curved, but the effect does not extend to more than a centimetre inwards, and as long as the plate is large enough to allow this margin all round there is no difficulty in getting an optically flat surface that will give accurate imagery of the star observed. Some time ago we carried out at the Admiralty Laboratory some tests to determine how far such a plate could be tilted before the upper surface of the mercury was appreciably out of the horizontal. An optical flat was fixed slightly above the mercury and interference fringes observed by light reflected at the two surfaces. It was just possible to notice a contraction of the fringes as the tilt approached one degree, the corresponding tilt of the mercury surface being under a quarter of a second of arc. A mercury pool has the defect that it must be protected against the wind and that when disturbed it requires time to settle down. This time is quite small provided the pool is not more than a millimetre deep and any vibration set up by movement of the apparatus can usually be relied on to damp out in a couple of seconds or so.

All things considered, I think no one can doubt that of the two methods of defining the vertical that of the mercury pool is a long way the more satisfactory for really accurate work. If the copper plate is level within a few minutes there is no risk of any error in the vertical defined by the normal to the mercury.

The second source of error lies in the measurement of the stars' zenith distance, and here the most satisfactory way seems to be to use a fixed angle and determine the times at which the various stars reach that altitude or zenith distance. It is not essential that the angle should be known with absolute accuracy since the method of working out the observations will look after that point. But it is in the highest degree essential that the angle shall remain constant to a fraction of a second for the whole series of stars observed. In using the method of equal altitudes with a theodolite one must set the telescope in the vertical circle and use that setting for all the stars observed. With an astrolabe one's standard angle is that between two polished faces of a prism. Of the two every one, I think, will agree that the prism method is the more reliable. The chief danger lies in each case in a change of temperature, causing a local distortion, and it can hardly be questioned that the built-up mechanism of the telescope and vertical circle is much more vulnerable in this respect than a glass prism. The prism has a definite advantage that if unequal heating does distort it, the defect will first become visible as a loss of definition of the star image. There is however no evidence so far during the period that these astrolabes have been in use that temperature changes ever affect the prism angle to amounts that matter.

The prismatic astrolabe as an instrument embodying the two main principles of definition of the vertical by means of a mercury surface and the use of a fixed measuring angle contained in a reflecting prism originated apparently with Claude and Driencourt some five and twenty years ago. In this instrument (see Fig. 1) the prism is a 60° one, and each beam of light (*i.e.* the direct one and that reflected from the mercury surface) is reflected once in the prism. This astrolabe has been extensively used and some very accurate work has been done with it. It was first brought to my notice about the end of the War by the then

Hydrographer, who was proposing to purchase one for the Hydrographic Service. I got very interested in this somewhat radical departure from standard methods of determining latitude and longitude, and a year or two later designed and made for the Hydrographic Service a modified form of the same thing, but making the prism rotatable about a horizontal axis so that each edge of the prism could be used in turn. By making one angle 60°, one less than 60° by a few minutes and the other more than 60°, we obtained an instrument that enabled three observations to be made on each star instead of one only. This astrolabe was described in one of the early numbers of the *Journal of Scientific Instruments*. Later I began to experiment with a design embodying the same two basic principles, but entirely different in optical design from what had been attempted before.

The 60° astrolabe can be used only with stars that reach an altitude of 60° above the horizon, while the new one observed stars at an altitude of 45°. A little consideration shows that more stars become available during a night's work with a 45° astrolabe than with the other instrument. It is difficult

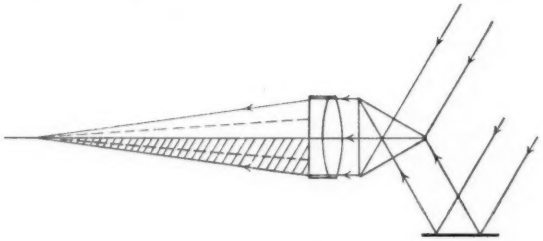


Fig. 1

to give an exact estimate, but very roughly the number of available stars is doubled.

While this increase in the number of stars that could be used was the main consideration that led to my designing the 45° astrolabe there were other points in connection with ultimate accuracy that had an important bearing. The first is that the disposition of the prism relatively to the telescope objective in the 60° astrolabe is unsound since it divides the objective at right angles to the direction of measurement.

Fig. 1 illustrates this point. The beam of light direct from the star enters the upper slanted face and is reflected internally in the lower. Thence it passes out of the prism and into the telescope so that it fills approximately the lower semicircle of the objective.

It is focussed on the focal plane and the bundle of light is shown shaded in the drawing. The principal ray of this bundle is shown in pecked line and it is clear that this ray must be inclined to the telescope's axis while the principal ray of the indirect bundle is equally inclined on the other side. Now no image formation can be perfect. The rays do not pass through a point but touch some form of caustic surface, and the best position of focus is where the waist of the bundle is smallest. There is no exact point. Between the positions A and B

(Fig. 2) the eye can perceive no difference in sharpness of the star image, but as the focal plane is pushed in from A to B the centre of the patch of light that forms the star image falls, whereas for the other bundle the centre of the star image would rise. It is easy to see from this that the two star images might appear to be in contact with one another if seen at A but out of contact if seen

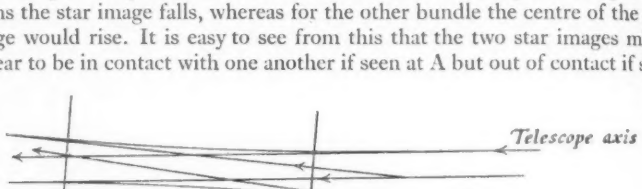


Fig. 2

at B. Thus for work of the highest accuracy this horizontal division of the aperture is fundamentally wrong, since it is quite impossible to ensure that the observer has such complete control over his ocular accommodation that he will always make his observations at A and never at B. There is, it is true, a vertical wire on the telescope that may assist in holding the accommodation, but the lighting of this wire can only be faint and it is not easy to assure oneself that the image formation is absolutely on the wire. There is no possible way of avoiding this undesirable division of the aperture with the 60° prism of the older astrolabe, and I think that the improved accuracy that has been found with the 45° instrument is a direct result of our having been able to avoid it.

There are other undesirable qualities in the 60° astrolabe resulting from the shape of the diffraction image. These will be referred to later.

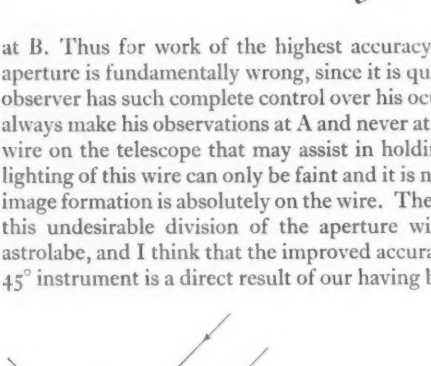


Fig. 3

The prismatic arrangement that enables stars to be observed at an altitude of 45° is shown in Fig. 3. A pentagonal or Prandl prism ABCDE is held in the position shown. The faces AE and CD are normally silvered, and light entering the face BC is reflected first at the face DE and then at the face CD and passes out of the prism across the face AB and thence into the telescope. The deflection of the beam, 90°, is twice the prism angle between the faces AE and CD and is thus constant even if the prism is slightly tilted.

In the astrolabe the face CD has a central part of the silvering cut away and a prism CFGD is cemented to the pentagonal. The angle of this prism is made

so that GF and AB are substantially parallel and light from the star reflected in the mercury traverses the prism through the central hole in the cemented interface CD. Thus there are two beams of light entering the telescope and their cross-sections are shown in Fig. 4. The principal ray is in each case the telescope axis, and it is obvious that the accommodation error of setting does not arise in this design.

The prism reflects the direct beam twice and the mercury reflects the indirect beam once, so that as the star moves in altitude the two star images move in opposite directions in the field, one up and the other down. The observation is made by noting when the two are in contact. The main function of the 36 × magnification telescope is merely to note more exactly when contact occurs. It is a magnifier and quite distinct in its function from the theodolite telescope where the measurement is made of the instants when the star crosses the spider-lines of the telescope. To get accuracy with the theodolite the angle between the line joining the cross-line to the nodal point of the objective must not depart by a fraction of a second from its position relative to the vertical axis. The astrolabe telescope could be tilted several minutes without introducing a tenth of a second inaccuracy in the latitude or longitude.

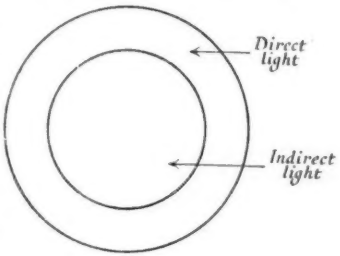


Fig. 4

Contact between two bright stars is not an observation for which the eye has a very high degree of acuity, and in order to reduce the errors of observation the same method is adopted as in the 60° astrolabe. A weak prism is fitted over half the aperture of the direct beam so that one-half of the direct beam, the outer zone of Fig. 4, is deflected sideways by about 1′ of arc, and a second direct image of the star is formed to the side of, but on the same horizontal level as, the others. These two star images subtend 35′ to 40′ at the eye. The observation is made by allowing the mercury image (single star) to pass between the direct image (duplicate star) and note the time when all three star images are in line. This can be done with a much narrower spread of observation errors than occurs when the direct star is single.

The star images resulting from cutting up the telescope aperture in this manner are affected by diffraction. The indirect star image is formed by a central circular part of the objective and the diffraction pattern will be circular, the image being slightly larger than would be the case if the whole aperture of the objective could be used. The diffraction patterns of the duplicate star images are extended outwards horizontally. The appearance of the field of view when the star is in "contact" is shown in a very exaggerated manner in Fig. 5. In the 60° astrolabe one image was formed by a semicircle of the objective and the duplicate images each by a quadrant. The corresponding diffraction patterns were as shown in Fig. 6. This gave such an unsymmetrical arrangement that it became necessary to cut down the apertures still further into three circular ones. It made the three diffraction patterns more symmet-

rical, but at the expense of loss of light. The diffraction patterns of Fig. 5 do not prevent a pretty accurate determination of the instant of contact.

In the form sketched in Fig. 3 the 45° astrolabe could yield only one observation on each star. The modified form of the 60° astrolabe where three shots

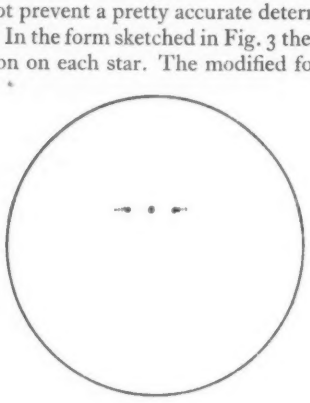


Fig. 5

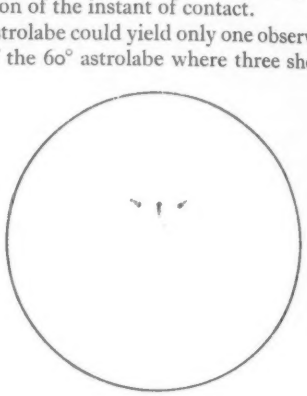


Fig. 6

were possible with each star was found to be so advantageous in reducing the number of stars to be observed that I had to introduce some form of repeated observation in the 45° instrument. This, done by means of a series of weak refracting prisms and the general principle, can be seen from Fig. 7.

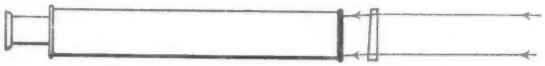


Fig. 7

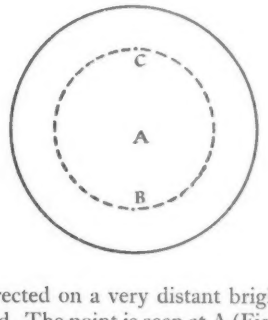


Fig. 8

Suppose a telescope T is directed on a very distant bright point which is focussed at the centre of the field. The point is seen at A (Fig. 8). Now place a prism in front of the telescope with its thin edge uppermost. The image is deflected to B. If the prism is turned with its thin edge downwards the image is deflected to C. In any other position of the prism the star image is somewhere in the circumference of the circle shown in pecked line. The angular radius of

this circle is the deflection angle of the prism, an invariable angle provided the prism is reasonably square (*i.e.* within a few degrees) with the beam which passes through it.

Suppose now three prisms are arranged in cells so that the light of the indirect beam passes through all three. Each prism can be rotated in its cell and is located by means of a pawl in either of two positions, *e.g.* B or C, edge upwards or edge downwards. The prisms are of deflecting angles α, 2α, and 4α, and if they are all arranged edge upwards the total deviation of the light is

$$\alpha+2\alpha+4\alpha=7\alpha$$

Now rotate the weakest prism in its cell by a half turn so that it is now turned edge downwards while the other two are still edge upwards. The deflection is now

$$-\alpha+2\alpha+4\alpha=5\alpha$$

It is evident that the following eight arrangements are possible:

1. $\alpha+2\alpha+4\alpha=7\alpha$
2. $-\alpha+2\alpha+4\alpha=5\alpha$
3. $\alpha-2\alpha+4\alpha=3\alpha$
4. $-\alpha-2\alpha+4\alpha=\alpha$
5. $\alpha+2\alpha-4\alpha=-\alpha$
6. $-\alpha+2\alpha-4\alpha=-3\alpha$
7. $\alpha-2\alpha-4\alpha=-5\alpha$
8. $-\alpha-2\alpha-4\alpha=-7\alpha$

It is to be noticed with this series that the amounts of deflection go in steps of 2α and that the total deflection taking account of plus and minus signs is zero. Also the weak prism requires a half turn after each shot; the intermediate a half turn after each second shot, and the strongest a half turn after the fourth shot.

This device is used in the 45° astrolabe and Messrs. Cooke, Troughton and Simms, who made the model illustrated, devised a most ingenious bevel gearing by means of which the necessary sequence of prism positions is ensured by giving a handle one complete turn after each observation. The handle has to be turned in one sense for a rising star and in the opposite for a setting one. The sequence of operations must start at the right point, *i.e.* either No. 1 or No. 8 of the series. In practice it is not necessary to make the deflection angles in the exact ratio 1 : 2 : 4. Slight manufacturing variations will modify the values of the steps, but the mean altitude observed is still that associated with the pentagonal prism.

After getting the shot the deflecting prism handle is given one complete turn. This brings down the indirect image to a point below the direct by an amount 2α (assuming the steps are all uniform). The indirect image continues to rise and the direct image to fall so that the next contact is made when each has moved through α, and the steps in the stars' altitude are uniform steps of α. The magnitude of the steps is a matter for personal choice, but we have found that if α is about 3′ there is sufficient time between shots to turn the handle, give the mercury time to settle, tilt the prism and correct the instrument in azimuth and still leave a margin to get ready to make the next observation.

For really accurate work it is important to keep the instrument approximately trained in azimuth. Movement in azimuth results in the images tracking across the field of view not in a true straight line but in very shallow curves indicated in an exaggerated manner in Fig. 9. They are truly in contact only at the centre of the field. If the observation is taken at the edge of the field a second order error in altitude obviously results, and second order errors in precise work must be guarded against. Accordingly, a vertical graticule line is fitted in the telescope and contacts should be made near this line though not necessarily exactly on it.

Here again I should like to make it clear that the telescope is mainly a magnifier that ensures more accurate work being done, but in respect of the vertical wire it is essential that this should roughly define a plane in the instrument, though accuracy to a few minutes only is all that is required. It needs a displacement sideways of about 11′ in the object space in order to make 1″ difference in the measured angle of 45°.

From the above description it will be seen that the design calls for no high mechanical accuracy anywhere. The vertical looks after itself under the action of gravity. The instrument is levelled for convenience, but only to a few minutes. The measured angle is the constant angle of the prism combined with refractive effects of the three refracting prisms. These need be only approximately square with the beam and need only turn through an approximate 180° for each successive shot. If the half turn is 2° out the measured step in altitude is $\alpha \cos 88°$, an error of only 0·1″ if α is 3′. This in itself is not a true error provided the prism locates *always* 2° out. It is then a *constant* error in the measured altitude, and, as will be seen later, any constant error automatically eliminates itself in the computation of the positions from the observed times. An error in location does however displace the star image sideways so that it has to be corrected by a tilt of the prism block. For this reason a touch of the tilting head and a touch of the azimuth head are usually required just before each shot.

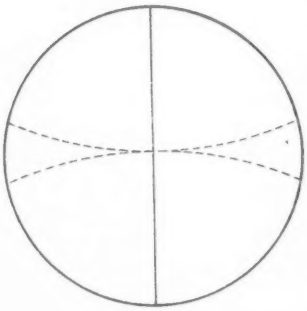


Fig. 9

Computation of the results to derive the latitude and longitude from them is carried out by the method of Marc St. Hilaire. The mean of the eight times associated with each star is used to determine, at the corresponding G.M.T., the true zenith distance of the star as seen from a false position, known however to be quite close to the true position. The calculation is a straightforward one of the third side of a spherical triangle when two sides (*i.e.* co-latitude and polar distance) and the included angle (*i.e.* stars' hour angle) are known. This calculation must be done with considerable care and usually to two decimal places in seconds of arc. This calculated zenith distance has to be compared with the observed zenith distance which is nominally 45°. Suppose the calculated zenith distance is $45° + p''$ and the stars' bearing is north-east. The

1. The 45° Prismatic Astrolabe

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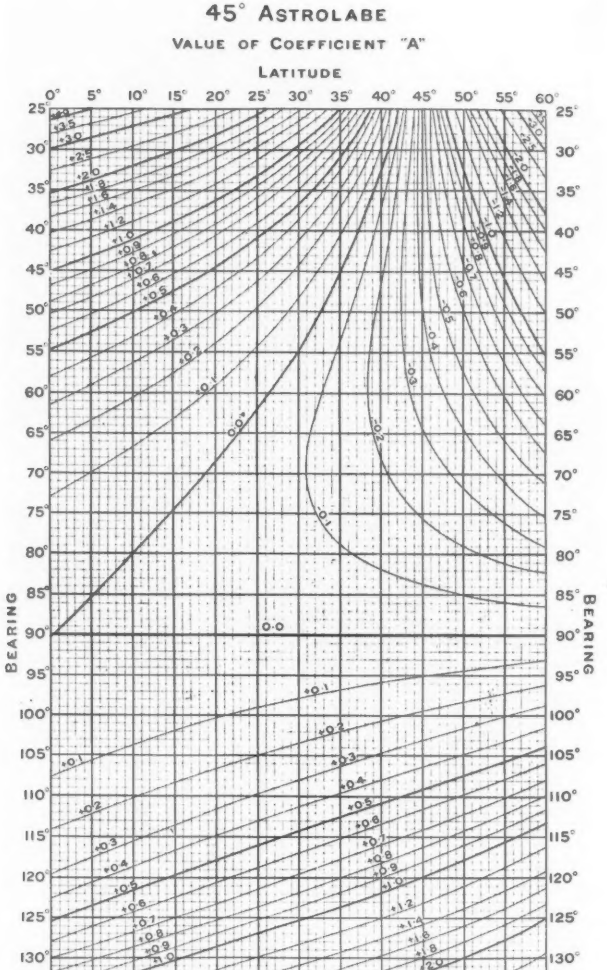


2. Diagram for the determination of second order correction in p *(page 437)*

observation tells one that the observer was not at the false position A (Fig. 10) but somewhere on the line BC drawn south-east and at distance p'' from A. But before doing this it is necessary to correct p by a small second order, a correction which will be explained later.

It is necessary in order to get accuracy to observe at least two stars in each quadrant, and the eight or more position lines would, if the observed altitudes were exactly 45° and all the times were noted with absolute accuracy, meet in a point which would be the true position. If the observed altitude is not 45° but $45°+r$, and all observations are made with absolute accuracy, the eight position lines would touch a circle of radius r and the centre of this circle would be the position. The quantity r contains all the systematic errors in the observed zenith distance, such as inexactness in making the pentagonal to a 90° angle, the second order error due to slightly wrong location of the deviating prisms, etc., and the constant error in refraction. It has to be assumed that the refraction is constant in all azimuths, but that it may differ by a constant amount throughout the series of observations from the tabulated value.

When we deal with the observation errors we find that any such error shifts the position line relatively to the circle that it is supposed to touch, and by the amount of the residual error.

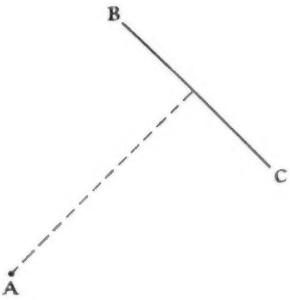


Fig. 10

Hence, if the position lines could be drawn as they are derived from computation the best position to derive from them would be the centre of that circle which is the best fit to the eight position lines. The best fit is defined as that which makes the sum of the squares of the lack of tangency a minimum. Instead of drawing the position lines the centre and the radius of the circle of best fit can be derived from the three equations:

$$Nr+a\Sigma \sin B+b\Sigma \cos B-\Sigma p=0$$
$$r\Sigma \sin B+a\Sigma \sin^2 B+b\Sigma \sin B \cos B-\Sigma p \sin B=0$$
$$r\Sigma \cos B+a\Sigma \sin B \cos B+b\Sigma \cos^2 B-\Sigma p \cos B=0$$

where N is the number of stars observed, B is the bearing of each star measured from north, p is the corrected intercept from the false position to the position line, and r, a, and b, the three quantities to be solved from the equations, are the radius of the circle r, and the coordinates a and b (departure and diff. lat.) of the centre of the circle relatively to the false position.

The second order correction of p arises in this way. The eight observations are spread over such a length of time that it cannot be assumed that uniform steps in altitude correspond to uniform steps in time. The amount of this correction can be expressed in a form $A \times C$, where A is a number whose value depends upon the latitude of the place of observation and the bearing of the star observed, C an instrumental constant directly derived from the measured angles of the refracting prisms. The value of A is plotted in a diagram (Plate 2) covering latitudes from 60° North to 60° South and bearings

from 25° to 165°. Over the bulk of this diagram the numerical value of A does not exceed 5. The instrumental constant is about 0·4″. The instrumental constant is determined by the makers from measurements of the prism angles. The value of A can easily be read to 0·1 and for a large part of the diagram to 0·01. It is thus possible to assess this second order correction to 0·01″ for a large number of practical cases.

Very little is needed for a description of the instrument (Plate 1). It consists of a base on three levelling screws which is mounted on a small stool about 15 inches high. The base contains the copper plate for holding the mercury pool. The mercury is cleaned and reduced to a suitable depth by dragging a clean glass rod over it.

Above the base plate is the main part of the instrument, capable of rotating in azimuth by running on rollers fixed to the base. A friction tight divided circle is fitted to the base, and this has to be turned so that its zero is true north. A magnetic compass is fitted to the upper part of the instrument, which is turned to a direction so that the needle points to its datum mark and the azimuth ring is then adjusted so as to read magnetic N against the datum mark on the cover. No great accuracy is required in doing this, as the azimuth ring is only required to enable the observer to set the instrument in approximately the right azimuth to pick up the star. A fine motion screw (endless tangent) is provided to allow of continuous training during observation to permit of the contacts being all observed at or near the graticule wire. The instrument has to be roughly levelled so that the mercury surface can be relied on.

The cover contains the prism box in which is fitted a framework carrying the Prandl Prism. This framework is pivoted at the bottom to allow the small rocking motion that has been previously described, this angular motion being round the telescope's axis. The telescope screws into the cover and has a magnification of 36 × with a field of rather more than 1°. Inside the cover is the series of three rotating prisms which lie in the path of the beam between the mercury pool and the telescope objective. The actuating handle also works a counter and shows which of the eight prism combinations is in use. The series is 1, 2, 3 . . . . 8 or 8, 7, 6 . . . . 1, according whether the star is rising or setting. Glass windows admit the two beams of light and the whole of the inside is thus effectively protected against wind that would otherwise ruffle the mercury surface. The windows are circular in shape and pinned so that they cannot rotate, and it is unnecessary to go to a high order of parallelism since their prismatic effect is all merged into the constant prism error. Attempts are however made to ensure that the prism effect of the windows is in the vertical plane.

Before starting observations it is necessary to draw up a programme of suitable stars with their times of reaching 45° altitude and the azimuth in which they will be seen. There are various methods by means of which a list of suitable stars can be made, and I think that the most convenient is by use of a star diagram with a transparent cursor. The stars can be referred to conveniently by means of their substellar points. These points move along parallels of latitude round the Earth's surface as the Earth rotates. For any point of observation on the Earth's surface a star will be at 45° altitude when its substellar point is 45° away, so that if this circle of 45° radius could be drawn round

the point of observation a star on this circle and not too nearly on a bearing north or south would be a suitable star to observe. It is not practicable to draw the 45° circle specially for the point of observation, and so a series of points upon the same meridian and at every 5° of latitude are chosen and the circles drawn for them, but to avoid the necessity of using a spherical globe a stereographic projection of the substellar points is made. The 45° circles become circles on the projection, and they are engraved on the underside of a transparent cursor. The projections of the stars are engraved on a brass circle, stars of northern declination on one side and of southern declination on the other. Sidereal time is engraved round the circumference of the disc. All that has to be done with this apparatus is to fix to begin with the limits of sidereal time within which the observations are to be made and then pick out those stars that come on the 45° circle of the latitude of the place of observation within the required limits of sidereal time. It is possible to take off from the diagram the sidereal time to about a couple of minutes at which the observation is to be made and very roughly the bearing. Usually it is best to choose two or three stars on each quadrant approximately on a quadrantal bearing. When the list of stars has been made it is as well to determine by calculation the times and bearings at which they will be observed.

After the observations are made the arithmetic mean of the eight times of contact of each star is calculated, and with this G.M.T. the stars' zenith distance is calculated for the false position. The formula is

$$\cos z = \sin l \sin d + \cos l \cos d \cos h$$
$$= \sin (l + \mathrm{M}) \sin d / \cos \mathrm{M} \text{ where } \tan \mathrm{M} = \cot d \cos h$$

This formula is suitable for logarithmic computation. If a calculating machine is available a more convenient formula is

$$\cos z = \tfrac{1}{2}\{\cos (l-d)(1+\cos h) - \cos (l+d)(1-\cos h)\}$$

With this formula the natural cosines can be taken direct to one second of arc from Giffard's Table of Natural Sines as eight-figure numbers with tables of interpolation to tenths of seconds. These tables of sines are unfortunately not also numbered from the bottom of the columns as cosines. The work involved is two multiplications on the machine of two pairs of eight-figured numbers.

If the calculation is done carefully it should be possible for a good observer to determine the position well inside a second of arc by observations on twelve stars instead of requiring a hundred, as is necessary with the French astrolabe. The length of time required to get twelve stars varies of course with the latitude and the time of year, but since stars of magnitude 6 are easily observable there should in most cases be no difficulty in getting through the observations in a couple of hours or so.

Early in September last a trial of the accuracy of the 45° astrolabe was made at the Royal Observatory, Greenwich, by two officers of the Hydrographic Service, Lieut.-Commander A. Jones, R.N., and Lieut.-Commander F. C. Woodhouse, R.N., neither of whom had used the 45° astrolabe before, though both had had some previous experience of the 60° instruments. Observations were obtained on four nights, twelve stars being observed by each officer on three nights and eight stars on the other.

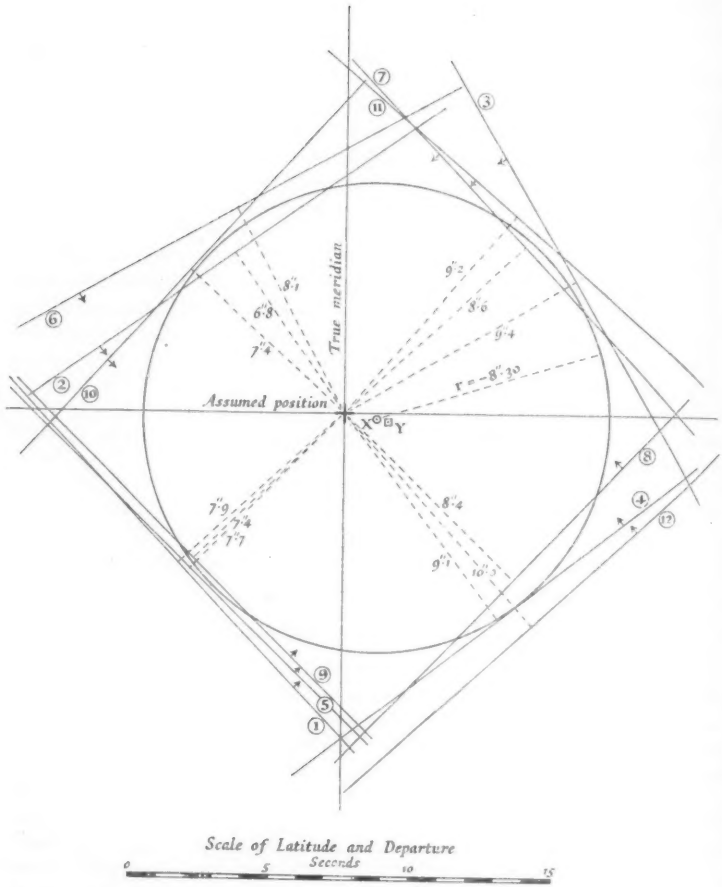


Fig. 11. Astrolabe Observations: R. O. Greenwich, 3 September 1930. Graphical Reduction

X is Position by these Observations 51° 28′ 35·80″ N. 1·83″ E.
Y is True Position 35·74″ 2·37″

The results obtained were as follows:

Lieut.-Commander A. Jones

2nd September	12 stars	error in lat.	−0·87″	error in long.	−1·70″
3rd ,,	12 ,,	,, ,,	+0·06″	,, ,,	−0·54″
4th ,,	8 ,,	,, ,,	+0·42″	,, ,,	−0·48″
8th ,,	12 ,,	,, ,,	+0·11″	,, ,,	+0·20″

Combining the observations in four nights the error in geographical position accepted from them is:

Error in latitude −0·11″. Error in longitude −0·55″.

Lieut.-Commander F. C. Woodhouse

2nd September	12 stars	error in lat.	−0·38″	error in long.	+0·28″
3rd ,,	8 ,,	,, ,,	+0·08″	,, ,,	−0·32″
4th ,,	12 ,,	,, ,,	+0·19″	,, ,,	+0·34″
8th ,,	12 ,,	,, ,,	+0·20″	,, ,,	−1·09″

Combining the observations of the three nights, giving half weight of the first, when the observations were regarded as experimental, the error in the geographical position accepted from them is

Error in latitude −0·06″. Error in longitude −0·15″.

A personal error in pressing the tapper would put the longitudes all one way but would not affect the latitude. It might be possible to determine this personal error and allow for it.

The Position Line diagram for one night's observations is shown in Fig. 11.

It is perhaps worth while noting that the two observers made errors in latitude of the same sign on each of the four nights, and that both had their maximum error on September 2. There are not sufficient data here to afford definite evidence, but it is possible that at a place like Greenwich, with the low-lying land near the river to the north and the higher land of Greenwich Park and Blackheath to the south, the stratification of the air above the Observatory is not always truly horizontal. If so, it is not impossible that refraction is not the same in all azimuths, and that the latitude errors are partly ascribable to this cause, but I do not wish to lay any stress on this point, as there is not sufficient evidence.

The 45° astrolabe as made for the Hydrographic Service is rather heavy for transport. Messrs. Cooke, Troughton and Simms have now taken in hand the design of a smaller model with a prism of 35 mm. aperture instead of 50 mm. This entails a small reduction in magnification and consequently a slightly increased spread in errors of observation, but it should still be possible to get a fix within one second of arc as a result of one night's work. The chief difference between the two astrolabes would lie in the brightness of the stars that could be observed. With the larger model it is possible to make use of stars as faint as magnitude 7. With the smaller one the surveyor would be limited to stars not fainter than magnitude 5.

Perhaps I might in conclusion suggest that for such purposes as a systematic determination of plumb-line errors the prismatic astrolabe is an ideal instrument for rapid and accurate work.

THE TAVISTOCK THEODOLITE: *A paper read with the preceding paper at the Afternoon Meeting of the Society on 19 January 1931, by*

MAJOR G. CHEETHAM, R.E.

IN February 1929 Captain E. R. L. Peake read a paper before this Society in which he described the Tavistock model of theodolite produced by Messrs. Cooke, Troughton and Simms, which was then in an experimental stage. This model is now in production, and one of the instruments was recently sent to the Ordnance Survey for trial. I propose to give an account of this trial. Before doing so I will describe the one important alteration in design which has been incorporated since Captain Peake's paper.

This alteration is in the method of reading the micrometers, and was designed by Captain Baker. It was referred to in the former paper, but as the design has since been modified, I shall describe it as now constructed. Provision is made for reading the mean value of measurements on opposite sides of the circle in one eyepiece. But, unlike recent continental models, separate eyepieces are provided for reading the micrometers on the horizontal and vertical circles respectively (F and E on Plate 1). These eyepieces are pivoted and can be swung into convenient positions on either side of the telescope in either face right or face left positions. The method of reading either micrometer is then identical, and I shall consequently describe the process for the horizontal circle only.

The images of two diametrically opposite graduations of the circle are brought together to a suitable focal plane by optical means, and the mean of the two readings is obtained by balancing these images about a mark. The movement of the images is carried out by travelling prisms which are actuated by a milled head (F^1) which at the same time moves the fine-reading scale in a corresponding manner.

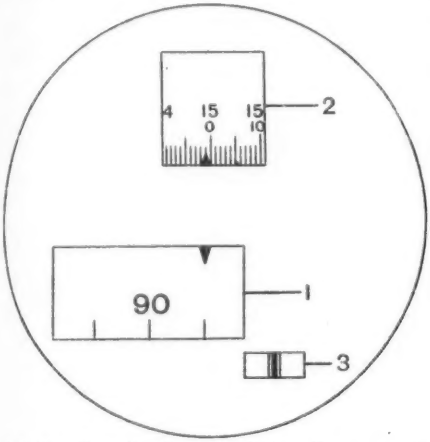
The view obtained in the eyepiece is seen in Fig. 1, where it will be seen that there are three apertures. In aperture 1 the circle divisions appear (the circle is divided to show degrees and 20 minutes). Aperture 2 shows the fine-reading scale which reads direct to the nearest second. In aperture 3 appear the images of the two circle divisions referred to above separated by a black band. The operation of setting is performed by rotating the milled head immediately below the eyepiece until the two images appear to be evenly balanced about the black band.

When this has been done, the reading is obtained as follows. The reading to the nearest 20 minutes is taken from aperture 1, thus, 90° 20′. The remaining minutes and seconds are obtained by reading aperture 2, in this case 14′ 59″. The whole reading is then 90° 20′ + 14′ 59″, or 90° 34′ 59″. It should be noted that the gap of light on either side of the black band may be varied by a simple adjustment to suit the individual taste of the observer.

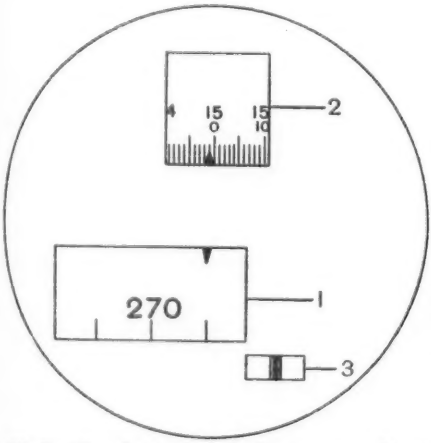
The object of the Tavistock Committee in 1926 when drawing up their specification was to produce an all-round instrument suitable for use in the Services and in the Dominions and Colonies. It was to be an instrument in which the reliability and general qualities of existing British instruments were

to be combined with the lightness and speed of operation of the new continental models.

The test to which we submitted the Tavistock instrument sent to us then was to see if its accuracy was of the right order and what sort of speed might be expected from it. Reports from abroad had indicated that the Zeiss model No. 1 Theodolite was sufficiently accurate for secondary work. One of these instruments, which had been purchased by the Ordnance Survey in November 1928, was therefore used under identical conditions with the Tavistock instrument to obtain comparative results.



(*a*) *Reading horizontal circle: Face Right* $90° 34' 59''$



(*b*) *Reading horizontal circle on same object: Face Left*

Fig. 1

Before starting to observe however a series of tests were made with the object of seeing what sort of variation would be obtained in the setting of the micrometer for one pointing of the telescope. A series of twenty settings were made by a number of observers for one pointing of the telescope. After a little practice, a range of 4 seconds was to be feared in the reading of the micrometer under identical lighting conditions, but by varying the incidence of the light on the reflectors, a range of 10 seconds was sometimes reached. This point will be referred to later.

The instrument was then set up on a concrete block and three targets were set up at about 70 yards from it. These targets consisted of adjustable vertical slits through which the zenith light was reflected by an inclined mirror; by adjusting these slits a very fine and clear mark was obtained. A series of rounds of angles was then observed by a number of different observers.

The results of these observations are shown in Fig. 2 in graphic form.

(1) shows observations with the Tavistock instrument using natural light for illuminating the circles. The horizontal axis shows the zero on the circle from which the round of angles was started. The vertical axis represents the measure of one angle in the round. Each dot represents a measure of the angle and the dots representing observations by a particular observer are joined up by lines

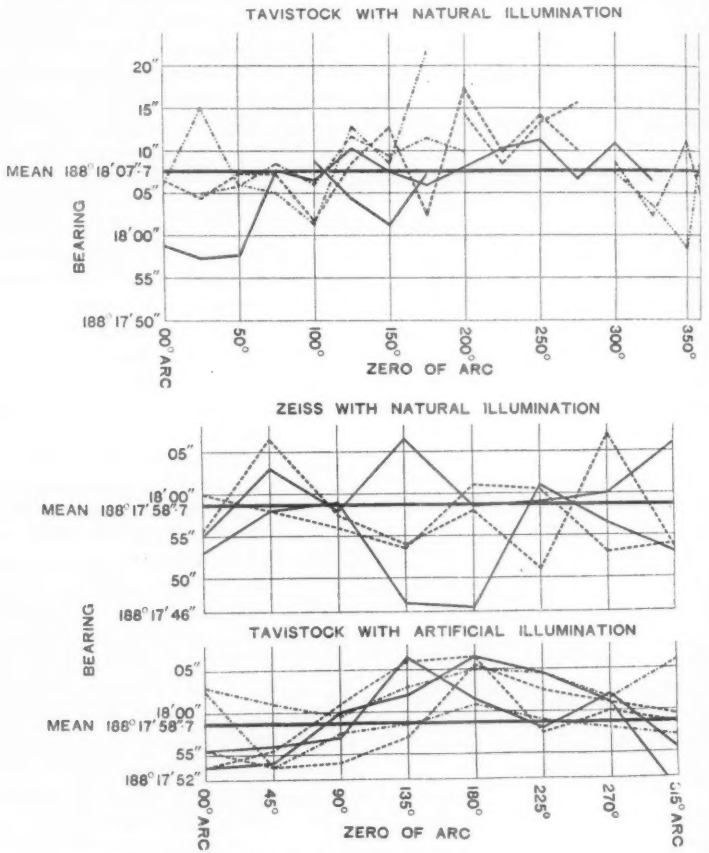
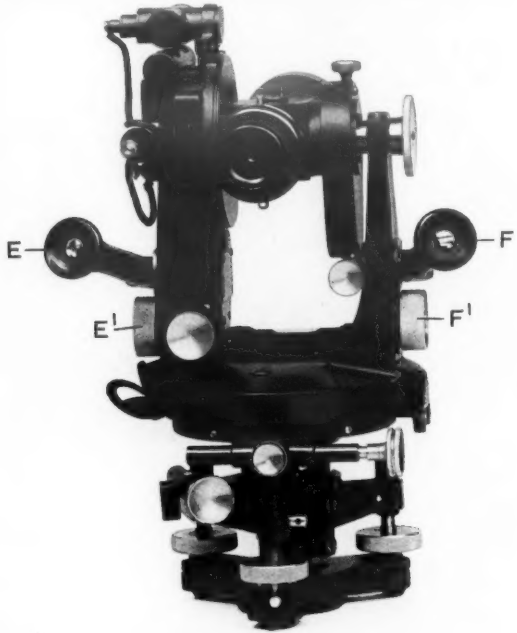
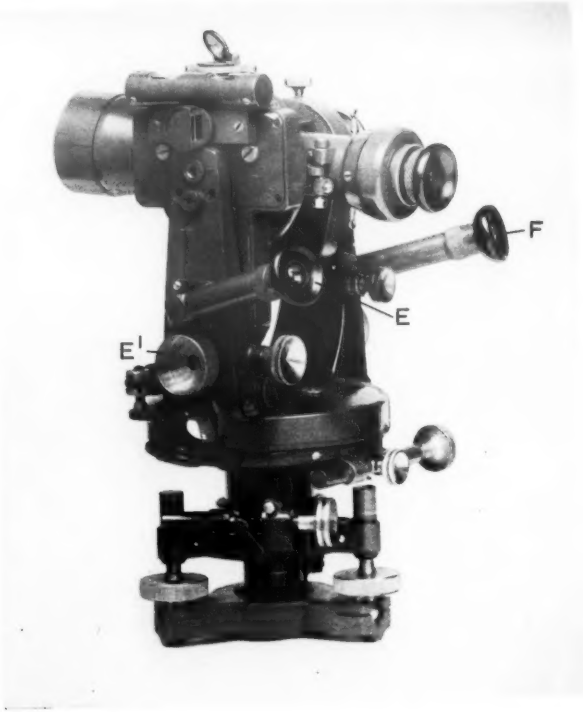


Fig. 2. Rounds of angles by different observers

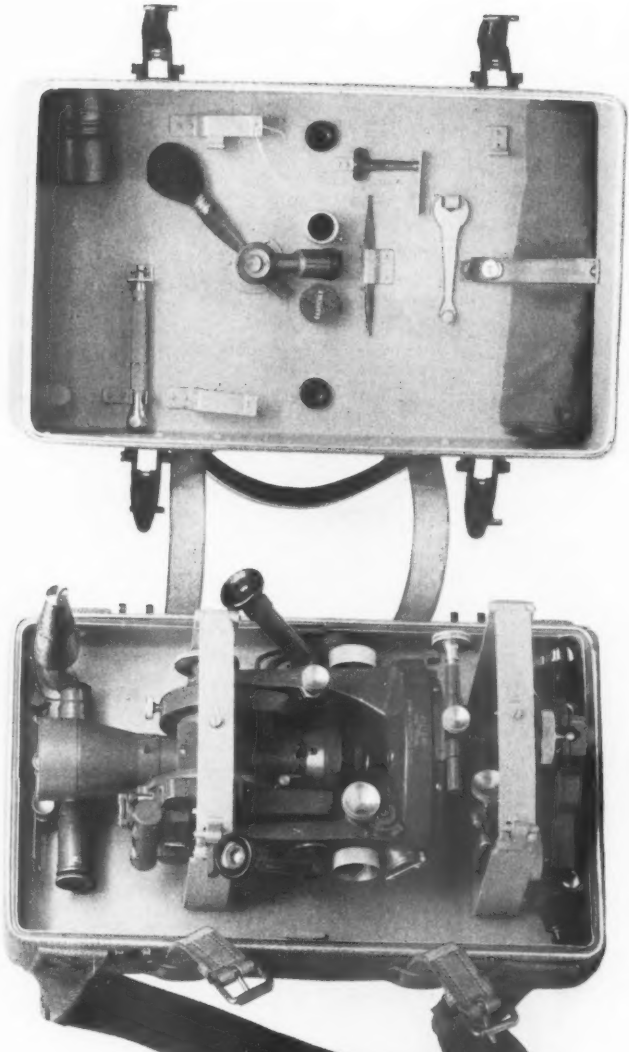
of a particular character, *i.e.* firm, dotted, etc. (2) is a similar diagram for the Zeiss instrument with natural illumination, and (3) for the Tavistock with artificial illumination.

The observers had all had considerable experience, but had not used the Tavistock instrument before. All those who observed with the Zeiss instrument had previous experience with it.





1. The Tavistock Theodolite



2. The Tavistock Theodolite packed for transport

The average closure of a round of angles on the R.O. was with the Tavistock (mean of 50 rounds) 2·7″, with the Zeiss (mean of 30 rounds) 7·0″.

The mean value of the value for the angle obtained by three observers with artificial lighting differed by less than 1 second. The average time taken by an observer to observe four rounds of angles, involving 16 pointings, two changes of face, and setting on four zeros, was 20 minutes with the Tavistock and 29 minutes with the Zeiss instrument. The quickest observer took 15 minutes, less than 1 minute a pointing.

The conclusions to be drawn from these observations appear to be the following:*

(1) These two instruments gave results of about the same order of accuracy.

(2) A considerable error may be introduced by the unequal incidence of natural lighting on the circle, and consequently if full advantage is to be taken of the potential accuracy of the instrument, artificial lighting must be used.

(3) Although the error of a single pointing may be as much as 5 seconds even when artificial lighting is used, yet by a proper routine of observing the mean of a number of pointings may give an accuracy of the order of 1 second. This accuracy is to be sought rather by such proper routine than by attempting impossibly fine reading. This point is being appreciated on the Continent, where the tendency in instruments of this size and type is now to design for a direct reading to the nearest 5 or even 10 seconds only.

There is a tendency in these figures for the observations to follow a curve. This is most marked in (3). It would appear that the variations are due to slight inequalities in the graduations of the circle. But in view of figures which I have received of observations carried out with collimators at York, this does not appear possible, and I cannot therefore account for this curve.

It is noticeable in the reports made by the observers who have used this instrument that they all say they like the instrument or refer to its ease of handling. It is very difficult to define this quality, which will be recognized at once by any one observing with the instrument. It means that all the minor details are well thought out. It is evidenced by the fact that four observers without previous acquaintance with the instrument were able to observe with it at once at a speed of about one pointing a minute.

One or two of these minor points may be mentioned. The excellent sights which are on both sides of the telescope have already been mentioned.

The reading of the micrometers gives a good example. Fig. 1 shows the view in the eyepiece of the Zeiss and Tavistock Theodolites on face right and face left.

In the Zeiss instrument it is necessary first to select the appropriate aperture for the horizontal circle, then to note if 10 minutes is to be added to the

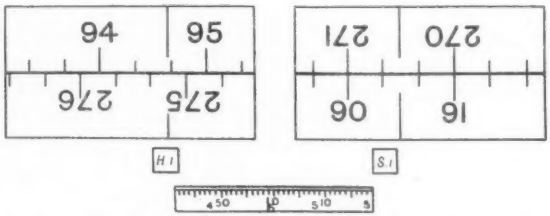
*It is interesting to note that the Survey of India have obtained very similar results with the Wild Universal 3¾″ Theodolite. In their Geodetic Report, vol. iv, p. 74, they give the results of observations with this instrument on three series of secondary triangles. Their method of observation included taking four rounds of angles on each zero. The greatest discrepancy in the values of the mean of the four measures of an angle so obtained was found to be about 6·5 seconds, and the triangular closure of the order of 2 seconds.

In comparing these results with those shown above for the Zeiss and Tavistock instruments it must be remembered that the latter are single measures and must therefore be expected to be less accurate.

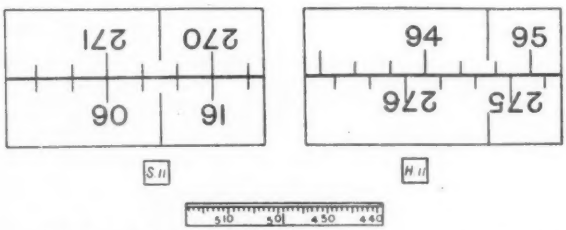
reading. Then if the instrument be in the face right position, all readings are made from left to right. If however it is in the face left position, the approximate reading is still from left to right, but the fine reading is reversed. In the Tavistock instrument these little inconveniences do not exist.

Another point that I personally appreciated was the fact that when traversing the telescope on to a mark there is a slight drag which enables one to come quietly on to the mark and not overshoot it, as I have sometimes done with instruments in which the movement is freer.

One point which we considered could be improved was the slow-motion



(*a*) *Reading horizontal circle, Zeiss Theodolite: Face Right 90° 34′ 59″*



(*b*) *Reading horizontal circle: Face Left on same object*

Fig. 3

screw of the horizontal circle. This has too rapid an action, possibly a thread with less pitch would remedy this.

No definite tests were made of the instrument in other respects, but the following points were noted as being of interest. It is possible to observe with it right up to the zenith and indeed to transit either end with the diagonal eyepiece attached. I see that the new Zeiss instruments are to be made capable of reading up to the zenith but will not be capable of transiting the eyepiece end with the diagonal eyepiece attached. The fact that the bubble can be set from the observing position after a pointing has been made immediately before the micrometers are read is a great advantage.

The instrument is designed for measuring angles by repetition, and that this has not introduced any appreciable errors is proved by the results of the observations quoted. I understand that this feature is now to be introduced in some continental instruments of this type.

Plate 2 shows the instrument packed in its box. It weighs:

Instrument	11·75 lbs.
Box complete with tools and spares	10·5 „
Total	22·25 „
Tripod	13·5 „

Finally, although it is not anticipated that instrumental adjustments will normally be required in the field, the makers claim that it is easy to dismantle and adjust, and they are, I believe, publishing a booklet giving the necessary instructions for doing so.

DISCUSSION

Before the paper the PRESIDENT (Admiral Sir WILLIAM GOODENOUGH) said: We are here this afternoon to listen to the description of two instruments which will be of great importance in geographical survey; the first particularly for determining accurately the position of the place that the instrument is in; the second for that and also—and here may I say I speak very much as an amateur and not as an expert—to determine the position of all such places as are in view. We hope that it will come to a considerable number to make use of such instruments of precision. It does not come to very many to really understand them; and it comes to very few indeed to have the brains, the application, and originality of thought which enable them to fashion such instruments. I will ask Instructor Captain Baker to commence, and then Major Cheetham will follow.

Instructor Captain Baker and Major Cheetham then read the papers printed above, and a discussion followed.

The ASTRONOMER ROYAL (Sir FRANK DYSON): I do not think one can say much about an instrument unless one has really used it, but I had the pleasure of seeing Instructor Captain Baker's instrument when Lieut.-Commander Jones and Lieut.-Commander Woodhouse had it at Greenwich. I looked through it then and it seemed to me that it was very easy to make observations. That is an essential point about an instrument. I agree entirely with what Captain Baker said about the importance of the level in determining positions. By this astrolabe you have the level. In the ordinary way, determining time with a small transit instrument, we always take ten levels in the course of the evening or as many observations of levels as of stars, and there is no question that on some nights it is possible for the level of the instrument to shift by as much as a second of arc. It is important to watch the level continually.

Then as regards the use of a prism, there I think it is a real advantage to obviate the measurement of large angles in this way, and has an advantage over the method of measurement by a circle. I am not quite sure that the alteration of the angle by temperature might not be rather more serious than Captain Baker thinks, because in spectroscopic observations people when they want to make observations for line-of-sight velocities are most scrupulously careful to keep their prisms at constant temperature. If you had a very bad alteration in the angle and very much curvature no doubt you would see it, but with the ordinary definition in the atmosphere I am not so certain that you would detect it. There might be liability to error in that way.

I must say the results obtained at Greenwich on the four nights seem to be extremely satisfactory. I do not think one could expect to obtain better results.

The errors were very small, and I do not think there is any occasion to put error down to differences of refraction, necessarily, though differences of refraction are certainly always possible to that amount. But the quantities were so small that I think Captain Baker can be very well satisfied with his instrument. I am sorry I have had no experience with the theodolite and so I cannot offer any remarks on Major Cheetham's paper.

The HYDROGRAPHER of the NAVY (Rear-Adm. H. P. DOUGLAS): It may interest listeners to hear about some observations taken in the year 1889 at Greenwich by Admiral Sir Herbert Purey-Cust, who is in the room this afternoon, and Admiral Sir Mostyn Field, who have both been Hydrographers in their time. They were sent to make observations as officers who were very good observers; and they were just about the same age as the officers who took the observations of which we have heard this afternoon. Therefore I think we can compare the observations taken in 1889 and compare the astrolabe against the 3-inch transit circle, without going into figures. I shall only talk about the transit circle because I think every one recognizes this instrument must be far better than the sextant with artificial horizon. The observations taken by Commander Field, as he then was, and Lieutenant Purey-Cust with the transit show in one case 2·66″ of error and in the other case 5·9″, whereas the errors obtained by the instrument under discussion, the differences from the true, are something in the neighbourhood of under half a second in longitude.

Another point to be remembered is that in 1889 the observations extended over a whole month (June 18–July 18), the two officers working as hard as they could taking observations, whereas we were able with the 45° prismatic astrolabe to take 392 observations of stars in four nights, and then only working about one to one and a half hours each night. We are supplying this instrument to all our Surveying Ships and are entirely satisfied with it. Not only is Instructor Captain Baker to be congratulated on it, but it seems a most excellent piece of work by the instrument-makers. We have had no trouble at all. It *is* on the heavy side, and I think the Army and shore services do not like it for that reason; but I understand the instrument-makers are getting out a smaller model, the only difference being that it will not be possible to observe a star down to magnitude 7, as can be done with the present instrument.

As to the Tavistock theodolite, there is one point to which Major Cheetham referred, and that is the ease with which it can be taken to pieces. We had a case in point in connection with one of these theodolites in H.M.S. *Endeavour*. When the ship was at Port Said recently they were testing the instrument and found a piece of dirt across the micrometer face. Without any trouble the officers were able to strip the instrument right down and remove the dirt.

One other point. The Astronomer Royal—and I think it shows he has some faith in the 45° Astrolabe—has asked if we can lend it to him to take observations at the Magnetic Observatory at Abinger, where he has no facilities for observing with a transit.

Dr. HAROLD KNOX-SHAW: I am very glad to have had the privilege of listening to Captain Baker's clear account of his very beautiful instrument. There is no question, I think, that it is a great improvement on the old French astrolabe, the only one of which I have had any previous experience. Apart from the fact that there are more stars at 45°, which perhaps is not a very important point considering how faint stars this instrument can observe (it is amazing to me that it is possible easily to observe stars of the 6th magnitude when there are so many glass faces through which the light has to pass and so many reflections)—there is the very important point on which Captain Baker laid stress, that in the 45° prismatic astrolabe the object glass is not cut in half horizontally by the prism. It was a very

serious defect of the old instrument that the images went through different-shaped parts of the object glass.

I have had an opportunity of reading the paper in proof and have tried hard to find serious criticisms, but I am afraid that all I can offer in that way are merely minor points. There is the point of the multiplication of the observations to seven or eight. I do not think that it can be claimed that eight observations of one star are eight times as good as one observation of eight stars. In the paper Captain Baker describes twelve stars as being equivalent to 100 with the French instrument. I presume—he does not mention it specifically—that it is necessary with the 45° prismatic astrolabe to use a chronograph. That may be all very well for a geodetic expedition, but for the smaller type of surveys a chronograph would be a rather troublesome thing to carry. Probably in these days of motor cars that is only a minor point. The time between the different star observations here is about 15 seconds, and it would not enable one to use any other form of recording, such as with a stop-watch, unless one had an assistant and employed the rather poor method of calling out "top."

I should like to ask Captain Baker for what reason he employed this particular method of reduction. There are two ways of computing these observations. You can either compute, as he has done, the altitude from an assumed position, assuming also of course the star's declination, and plot the differences between these computed altitudes and the assumed altitude of 45°, or you can, as Dr. Ball and I did in Egypt, assume your altitude, the star's declination and latitude, and compute the time and compare that with the time actually observed. I think there are quite definite advantages—at least I used to think so, for it is ten years since I really thought about this—in the latter method. No doubt Captain Baker has found good reasons for using the one he does. I think the accuracy of the observations at Greenwich is astounding. I would not like to suggest that such an irregularity as change in refraction could occur at Greenwich, but I know it was our experience in Egypt, that night-to-night variations of that kind did occur, even larger than these observations would suggest. We used to find the agreement between stars on one night was much more close than between those observed on different nights, and the only reason we could find was that it was due to changes in refraction due to apparent shifting of the zenith.

The PRESIDENT: We should be sorry if a discussion of this kind took place without hearing something from Mr. Reeves on the subject.

Mr. REEVES: I have been interested in the prismatic astrolabe ever since Messrs. Claude and Driencourt first brought it out, and although perhaps rather doubtful at first, soon became convinced that this was the right sort of instrument for equal altitude observations. As Captain Baker states, very accurate work has been done with this instrument during the twenty-five years it has been in use. On small expeditions weight and carriage are frequently serious considerations, and it seemed too much to expect that a separate instrument, which could not be used for any other purpose than giving an altitude of 60°, should as a rule be taken. I therefore designed an attachment for prismatic astrolabe observations which can be fitted to a theodolite and taken off when not required. Very good results have been obtained with this, and it has been found possible for two men observing at the same time and place, with different instruments, to determine the latitude to the same second of arc, and this with comparatively few star observations.

I have listened to the paper just read with particular interest, but cannot help feeling that to lower the altitude angle from 60° to 45° is a mistake, and on the whole more likely to introduce error into the results than increase their accuracy. Captain Baker states that the main consideration that led him to make this alteration was the increase in the number of stars that could be used; but an

inspection of the very complete star tables recently computed under the superintendence of Mr. Weld Arnold, of the American Geographical Society's School of Survey, and published through the generosity of Dr. Hamilton Rice, will show that for the 60-degree prismatic astrolabe there are far more stars suitable for use than a man can possibly observe. For instance, in latitude 12° N. there are over 1000 stars, or 500 twice over, that can be used in every twenty-four hours, which gives an average of one in just under a minute and a half, while for latitude 51° N. there are about 700 stars in the twenty-four hours, or on the average one in every 2 minutes. With this number of suitable stars available I fail to see that there really is anything in Captain Baker's principal reason for lowering the altitude. It is impossible to take accurate observations very rapidly in succession: the eye requires rest and a certain time must be allowed for setting the instrument to the new azimuth of each star as it comes along.

By lowering the altitude from 60° to 45° the effect and uncertainty of the refraction of the atmosphere is increased very considerably, and it seems to me that there would be great chance of introducing error, especially as we are attempting to obtain results to single seconds of arc, or even fractions of a second. As has been pointed out in the paper, what is of the greatest importance is that the altitude, even if not quite correct, should be exactly the same for the different stars in all directions round the horizon, which can only be the case if the refraction is the same for the same altitude in every direction. Owing to abnormal atmospheric conditions, especially in the tropics, this is certainly not always the case, and unless the altitude is kept high there are occasions when errors are likely to be introduced through this inequality in the refraction. The accuracy of the Talcott, or Zenith Telescope method of determining latitude is, in great measure, due to the fact that the observations are taken close to the zenith where there is no refraction to allow for. From what I know of prismatic astrolabe observations I fail to see any real reason for reducing the angle from 60° to 45°, and feel sure that there are times when we should lose rather than gain in accuracy by doing this.

Brigadier H. S. L. WINTERBOTHAM (Director-General, Ordnance Survey): This is equivalent to a well-deserved double benefit for Captain Baker. Whereas the whole of one instrument may be said to be his, the reading devices of the other are also his. The Astronomer Royal says that we soldiers refrain from the use of a large instrument of the astrolabe type shown because it is too heavy for us. True. We have not got a survey ship always with us to carry our minor affairs, and it is not, as Dr. Knox-Shaw says, a question which is solved by the introduction of motor cars. On a boundary commission or a topographical survey, in the heart of Africa, in Ceylon or, in fact, anywhere in the tropical belt, it is possible to take an instrument by car within some distance of the actual point of observation, whilst still leaving some arduous hours of climbing ahead. That final manhandling makes a vast difference in the type of instrument one is prepared to use.

As regards the astrolabe, then, we soldiers are not likely to use it. It does not provide a horizontal measure; and if it comes to a question of an astrolabe attachment to the end of the theodolite, you come back to the fact that it is the bubble error which is the guiding factor.

[*Note by Ed. G.J.*—This is a misapprehension. The astrolabe attachment, like the complete instrument, relies for level on a free mercury surface, not a bubble.]

Soldier and sailor surveys differ, too, in another way. As a rule, though not always, the soldier is working in connection with triangulation. Our dealings with those unpleasantly nocturnal heavenly bodies are not so frequent as in the case of the sailor. We are, in fact, generally in touch with a more accurate foundation for our work.

With regard to the Tavistock theodolite surveyors in Europe have a different problem to what is normal in the dominions. You may say that out of every half-dozen instruments in a European survey department, five will be of a quite minor type for tertiary or lower order work; and the European surveyor is, after all, very close to the manufacturer, so that he can send his instruments back if anything happens. It is, then, only, say, one surveyor in six who wants the type of theodolite which we are here considering. The same thing, I think, applies in India, though I have not been there, and I know it applies in tropical dependencies where native labour is cheap and plentiful. Native surveyors are learning their job much quicker and with more intelligence than one would have thought possible, but they are confined to simple methods and they need not read to the closeness which the European surveyor may want for his different purposes. Both, then, in Europe and in some tropical dependencies triangulation still remains in that sequence of orders 1st, 2nd, 3rd, 4th, and sometimes 5th. It is different in newer and white men's countries. There a field hand may go to remote places, and has to carry his instrument with him. He will only carry the one, and that must give him all the precision which he may want in the most exacting case. He will take one which gives the required precision with the least weight. The other qualities he looks for are robustness of manufacture and accessibility to parts if he has to get at them. In the future in such surveys we shall see much fewer "orders" because all angular measures will be of much the same precision.

When some years ago Admiral Douglas, Brigadier-General Jack, and myself invited theodolite manufacturers to collogue with us in Devonshire, we studied all those points which we thought should be included in the small theodolite of the future. We might not all have been very clever people, but our collective wisdom was something not to be neglected. We produced, in fact, a specification for this very "Tavistock" theodolite. That specification Messrs. Cooke, Troughton and Simms have, I think, very ably worked up to, and I think we can be satisfied that we have now entered the first class of design and manufacture. Personally I am entirely satisfied.

Mr. HINKS: I have, Sir, been particularly interested in the report of the tests of the Tavistock theodolite, of which I saw the original drawing before any of the earlier models were made. It struck me as being a little disappointing perhaps that the range of pointing of a single observer upon one perfect mark was as great as 4 seconds, because it strikes me that that is a considerably greater range than one will get with one of the continental models, at any rate; and it is certainly considerably greater than the range with which I found myself confronted on a very cold morning on the terrace of the Polytechnikum in Zurich. But that may be mixed up with the extraordinary complexity of a periodic error depending upon the zero which has been so clearly shown by Major Cheetham and which he says is definitely not due to division error. If it is not due to division error one wonders what it is due to. It is the thing that must be investigated, because one cannot help thinking that a periodic error which ought not to be there must be due to something which can be found out, and when it is found out it will probably lead to greatly increased accuracy and decreased range of the setting. I venture to suspect that when this is eliminated, no doubt after a considerable hunt, it may be considered worth while to go back to estimating in tenths of seconds. I have always had considerable liking for reading one's instruments as accurately as one can read them. It may be partiality or foolishness, but it seems to me that when you can read an angle to tenths of seconds it is decidedly interesting to do so and see what happens. Therefore I regret that there appears to be a practice at present of merely recording the whole second and neglecting the estimation of the tenths.

At any rate, I feel pretty sure that when one tries to find out what that error is due to it will be decidedly worth while to take the tenths in the process.

With that little criticism I would like to be allowed to join with others in expressing great admiration for the skill which Captain Baker has shown in designing the 45° prismatic astrolabe. I am not sure how far it is at all the same as an instrument of which I have a very imperfect recollection, shown by Professor Nušl at the Astronomical Congress in Cambridge in 1925. If I remember rightly he had a sort of prismatic astrolabe into which one looked down at 45°. I have no more recollection of it than that. I also congratulate Captain Baker very heartily upon his ingenuity in discovering the way to circumvent the patents of my friend Mr. Wild. It takes some skill to get round the patents which defend the instruments of Wild, and the instruments of Zeiss which I understand are manufactured under licence from Wild. Captain Baker is to be congratulated upon the brilliant idea which has, I think, definitely produced a better solution.

The PRESIDENT: It rests with me to offer to both our lecturers the very hearty thanks of this Society. Fortunately for you and for me it is not necessary for me to make any personal remarks about the instruments. But we are very much to be congratulated that people have found the time and have, as I said earlier, the brains and ingenuity to work away at these things; not to be discouraged but to go on with them. I ask to be allowed, on behalf of the Society, to thank both our lecturers for their remarks and for having given us the opportunity of enjoying what, I say with all sincerity, is a feast of instrumental wisdom. A word has been said—and I would like to add to it—of congratulation to the makers of the instruments. I happen to have in my possession a sextant made by Messrs. Cooke, Troughton and Simms which was given to my father in the year 1851—I do not know when it was made—and it is in the most beautiful state of precision now. Please accept, Captain Baker and Major Cheetham, out most grateful thanks.

MESSRS. COOKE, TROUGHTON AND SIMMS, *who have seen Major Cheetham's paper in proof, send us the following note:*

We have been much interested in Major Cheetham's paper in which he describes the Tavistock Theodolite and summarizes the results obtained by the Ordnance Survey with one of these instruments.

We endorse his conclusion that it is advisable to use artificial light when it is desired to take full advantage of the accuracy of this instrument, or if this is not possible, it is advisable to readjust the angle of the illuminating reflector as little as possible.

We are quite unable to explain the periodic tendency exhibited in the graphs of readings obtained, particularly as each instrument is thoroughly tested at our York Works before despatch. The determination of the mean graduation error is made by the methods developed by Dr. Heuvelink* and is $\pm 1{\cdot}04''$ for the instrument in question; this figure includes the errors of pointing.

When this instrument, No. Y1763, was tested, two collimators were set at an angle exceeding 45° by about 35 seconds, and this angle was measured in four series of nine circle positions. The angle was measured several times forwards and backwards in each circle position in order to provide means for separating errors of dividing from errors of observation, and the circle positions were so chosen that the graduations utilized in each series were evenly distributed round the circle and were completely independent. Our practice is to carry out a programme for thirty-six circle positions distributed over four series each consisting of nine circle positions.

*"Die Prüfung der Kreisteilungen von Theodoliten und Universalinstrumenten," published in the *Zeitschrift für Instrumentenkunde*, 1925, Part 2.

Unfortunately this particular instrument is not now available for a further test, but we have used a somewhat different method to determine the diametral errors of a recently divided glass circle at every 10°. The result is indicated on the accompanying graph* in which the dotted line records the diametral errors as determined from one set of observations (the mean error being ±0·50″) and the full line records the diametral errors as determined from three sets of observations. The mean error is then reduced to ±0·29″. Almost identical mean errors were obtained by the Heuvelink method, but this latter method does not allow the actual determination of the diametral errors. These figures are for instrument No. Y2167.

Major Cheetham draws attention to the need for a finer pitch slow-motion screw to the upper plate, and in this respect the instrument he used is out of date. All recent instruments are fitted with a two-speed differential slow-motion screw to both the horizontal and vertical circles. The coarse screw is of about the same pitch as formerly, and one turn moves the telescope through about 30 minutes while the differential movement is about six times as fine, one turn moving the telescope through about 5 minutes.

MAJOR E. H. M. CLIFFORD *sends the following note:*

The "Tavistock" theodolite, as Major Peake told us in his paper two years ago and as Brigadier Winterbotham has reminded us, has been designed as a result of a conference representing Service users and British instrument makers. That conference was held at the instigation of Brigadier Winterbotham, then head of the Geographical Section, General Staff, and we in that Section have, as a matter of course, maintained close touch with the makers ever since. An advance model of the instrument was shown at an exhibition organized by the Optical Society in the summer of 1929, but a number of modifications were found necessary, and it was only in July 1930 that the War Office were able to secure delivery of one.

This instrument I was able to take out one day last August to the Hog's Back, where I carried out on behalf of the Geographical Section a number of tests, which gave very similar results to those obtained by the Ordnance Survey. The range of micrometer settings, with the instrument clamped, came out at 4″. For the measurement of horizontal angles I used the best-defined distant objects in view. Taking readings on twelve different portions of the arc, the range of eleven of these was 10″; the twelfth, which I suspect of having been a bad setting, increased this range to 16″.

I then tried a series of subtense measurements, using seven repetitions (as the slow-motion screws would not give more), again on natural objects in the distance. These objects, I should add, were only moderately good targets, though the best I could see. The results were as follows:

Face.	*Swing.*	*Arc.*	*Mean Subtense Angle.*	*Range of individual measurement.*	
R.	R.	120°	0° 31′ 38″	14″	Total range of twenty-eight measurements 16½″
R.	L.	175°	42″	6″	
L.	R.	280°	40″	11″	
L.	L.	340°	39″	10½″	

There is of course a fundamental difference between these rather crude field

*The graph is not suitable for reproduction. It shows that the greater part of these small errors can be represented by a simple sine curve, and that the residual errors are of the order of 0·10″ or less.—ED. *G.J.*

tests as made by the surveyor and the highly refined collimator tests employed and quoted by the makers. And I am quite certain that a good deal of confusion is caused between the two.

I must confess that I had considerable doubts as to the possibility of pointing so small an instrument with sufficient accuracy to justify micrometer arrangements reading to single seconds. And I think my own tests and those carried out by the Ordnance Survey still leave a small element of that doubt. However, since those tests were made, Messrs. Cooke, Troughton and Simms have fitted a two-speed slow-motion screw, the coarser screw to put the cross-hairs nearly on, the other, which is very fine indeed, for the final setting. I have tried this in their works on collimator tests and am bound to say that it is most successful and results in a really well-balanced instrument as between the delicacy of pointing and of micrometer readings.

There can of course be no doubt that the use of artificial illumination of the circles is bound to give more consistent readings than natural illumination; but I am intrigued by the fact that in the Ordnance Survey tests the natural illumination values were consistently higher than those artificially illuminated. One would have expected the former to be straddled across the latter.

In the matter of adjustments, when I visited Messrs. Cooke, Troughton and Simms' works, an instrument was stripped and reassembled for me; there is certainly nothing complicated or difficult about it. It is not until one sees the "box of tricks" opened up like that, that one can appreciate the simplicity and robustness of design, combined with accuracy and delicacy in the train of prisms. It was described in Major Peake's paper.

I wish to join with Major Cheetham in expressing gratitude for the excellent star sights.

All three makers of this new development in theodolite design—Wild, Zeiss, and "Tavistock"—provide a prism vision of the verticle bubble; and, instead of reading the scale positions of the ends of the bubble, the observer moves the bubble, and with it the telescope but not the arc, until the two ends of the bubble fit side by side in the prism. I understand that this method gives a definitely greater accuracy with the same bubble; and it has of course been developed primarily to save the observer from having to walk round to get a side view of the bubble. That is all right—or very nearly so—for terrestrial observations; discussion of this feature with other survey officers has however strengthened my belief that, for survey astronomy, it is unsound. Once the instrument has been carefully levelled, the bubble should be left severely alone. Besides that, rapid observation is required, and it is, in the nature of things, quicker to read a bubble than to establish a coincidence setting. The bubble at present fitted to the "Tavistock" is, I gather, a 10″ one. I believe that it should not be at all impossible to contrive means by which the bubble can be read by the observer, without moving, in a mirror, or even in the present prism; but the designer must not overlook the necessity for identifying which end of the bubble is which. As the micrometers read to single seconds, about a 4″ bubble would be needed. It is also worth pointing out that the coincidence setting method invites trouble through touching the wrong slow-motion screw first—a very easy thing to do even in daylight, doubly so in the dark, even for the experienced observer.

We now have two of these instruments in use abroad, though there has not yet been time enough to receive reports as to their behaviour. Every one, however up to date, has been in agreement as to their being handy and pleasant to use. But the makers want to watch it that the micrometer drums do not turn too freely: there seems to be a marked tendency for this in all three makes of this new development—Wild, Zeiss, and "Tavistock."

THE PURCELL SOURCE OF THE COLUMBIA RIVER

J. MONROE THORINGTON AND EATON CROMWELL

THE name "Purcell Range" was used by Captain Palliser[1] on the map of his expedition (1857–60) to designate the mountains between Findlay creek and St. Mary river. G. M. Dawson[2] amplified the conception to include the territory between the Rocky Mountain trench and Kootenay lake, but did not define north or south boundaries. Reginald Daly[3] states that "the Purcell Range is bounded by the Rocky Mountain trench [Columbia river], the Purcell trench [Beaver and Duncan rivers, and Kootenay lake], and the portion of the Kootenay valley stretching from Jennings, Montana, to Bonner's Ferry, Idaho."

The portion of the Rocky Mountain trench forming the eastern boundary of the Purcell Range contains in it the low divide between the northward-flowing Columbia and the southward-flowing Kootenay, the two rivers at one time being connected by a canal.

Discovery of the source of the Columbia river is accredited to David Thompson, geographer and explorer of the North West Company. Following his traverse of Howse pass, in 1807, to the western slope of the Rocky Mountains, he considered that the river rose in Columbia lake. In his own words one reads,[4] "At the foot of the above steep measured Mountains is the scource of the Columbia River, it is a Lake of nine Miles in length by 1¼ miles in width, it's direction nearly due south and north, it receives no Water from the east, nor from the high rolling lands from Mount Nelson on the West, but appeared wholly supplied by springs in the Lake, it appeared to have always the same level; and from it's north end it sends out a Brook which forms a second Lake [Windermere], from which I measured the Mountains."

Again he writes,[5] " I could never pass this singular place without admiring it's situation, and romantic bold scenery which I have already described; other Rivers have their scources [*sic*] so ramified in Rills and Brooks that it is not easy to determine the parent stream, this is not the case with the Columbia River,

[1] "The Journals, Detailed Reports and Observations Relative to the Exploration by Captain Palliser' (London, 1863). The range takes its name from Goodwin Purcell, "The O'Leary," M.D. (1817–76). Dr. O'Leary held the chair of Therapeutics and Medical Jurisprudence at Queen's University, Cork, at the time of the Palliser Expedition, and was a member of the Committee, with Roderick Murchison and others, which selected scientists for the expedition. Dr. Hector, at this time, had just received his M.D. from Edinburgh, where Purcell was graduated more than twenty years before. Palliser's home was in the south of Ireland, and Hector was later responsible for the expedition's map. Purcell's obituary is to be found in *The Lancet* (London) for 26 August 1876.

St. Mary river is the Skirmish river of the Palliser map. It derives its present name from the station of the Immaculate Heart of Mary among the Kootenay Indians, visited by Father De Smet in 1845.

[2] "Preliminary Report of the Physical and Geographical Features of that portion of the Rocky Mountains between Latitude 49° and 51° 30′," Annual Report, 1885, Geological and Natural History Survey of Canada.

[3] "The Nomenclature of the North American Cordillera between the 47th and 53rd parallels of Latitude," *G.J.*, vol. 27, 586.

[4] "Thompson's Narrative' (Champlain Society, Toronto, 1915), 404.

[5] *Idem*, 458.

near the foot of a steep secondary mountain, surrounded by a fine grassy Plain, lies it's scource, in a fine Lake of about eleven square miles of area, from which issues it's wild rapid Stream, yet navigable to the sea, it's descent is great."

This was the conception current for the major part of the last century. Walter Moberly, construction engineer for the Canadian Pacific railroad, writing in 1866, says,[1] " The Columbia Lake is the source of the great river of that name."

Lewis R. Freeman, a competent observer of rivers, has recently shown that that matter is subject to other interpretation. He states,[2] "One is usually told that the source of the Columbia is in Canal Flats, a hundred and fifty miles above Golden, and immediately south of a wonderfully lovely mountain-begirt lake that bears the same name as the river. This is true in a sense, although, strictly speaking, the real source of the river—the one rising at the point the greatest distance from its mouth—would be the longest of the many mountain creeks which converge upon Columbia lake from the encompassing amphitheatre of the Rockies and Selkirks. This is probably Dutch creek, which rises in the perpetual snows of the Selkirks and sends down a roaring torrent of grey-green glacier water into the western side of Columbia lake. Scarcely less distant from the mouth of the Columbia are the heads of Toby and Horsethief creeks, both of which bring splendid volumes of water to the mother river just below Lake Windermere."

There is no evidence that David Thompson penetrated to the Purcell glaciers above Windermere or Columbia lakes from which spring the main feeders of the upper river. It is not easy to explain his failure to mention Dutch creek, although his observations of the lake seem to have been made chiefly during winter months.

The Purcell Range between Lake Windermere and Kootenay lake is divided for convenience into East and West Kootenay districts, the range running nearly north and south and forming a watershed between them. The highest peaks, centering about Mounts Jumbo and Farnham, lie to the east of this watershed between Horsethief and Toby creeks. The eastern streams are longer and of a more gentle gradient than those of West Kootenay, whose valleys, generally, are more precipitous and heavily forested.

As early as the days of the Palliser expedition there were rumours of passes across the range, westward from Lake Windermere. It is possible that Earl Grey (Wells) pass was even then in use by Indians, and this route through the valley of Toby creek to Hamill creek[3] is the only one of practical value at the present time, leading from Invermere to Argenta on Kootenay lake.

In 1910 T. G. Longstaff and A. O. Wheeler,[4] with Conrad Kain, crossed the range through a pass at the head of Bugaboo creek, but were unable to take their packtrain to Howser lake. A winter crossing by this route by Wells and

[1] 'The Rocks and Rivers of British Columbia' (London, 1885), 50.

[2] 'Down the Columbia' (New York, 1921), 21.

[3] Thomas Hammil (thus Baillie-Grohman spells the name), a young prospector, was sent in the early eighties by Captain Ainsworth, founder of the Oregon Navigation Co., to examine the mining possibilities at Kootenay lake. He was murdered by R. E. Sprowle, a rival, who rediscovered the mineral deposits first noticed in 1825 by the botanist, David Douglas.

[4] *Canadian Alpine Journal*, iii, 26; reprinted from *G.J.*, vol. 37, 589.

a companion, on showshoes, is stated by Longstaff to have been made some twelve years before. More recently Kain has crossed from the head of Jumbo fork (Toby creek) to Glacier creek, a variant of the Earl Grey route without particular advantage. The latter route, since 1928, has become almost impossible for horses, due to immense windfalls resulting from forest fires in Toby valley. South of this crossing of the range there is no other until the valley of St. Mary river (Sawyer pass) is reached, some 35 miles to the south.

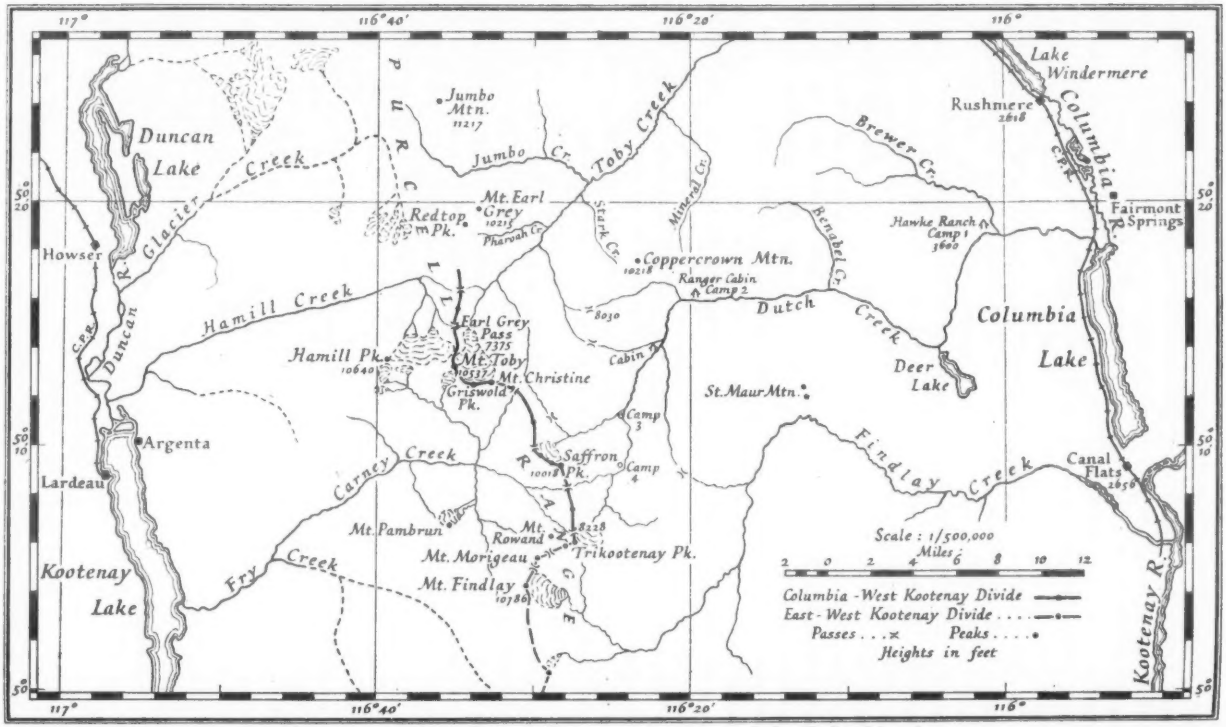
In 1928 O. E. Cromwell, J. G. Hillhouse, J. M. Thorington, and Conrad Kain visited the peaks and snowfields at the heads of Toby and Horsethief creeks.[1] Our work included ascents at the southern margin of Toby snowfield, the extremity of the mapped area of mountain territory in this direction. Looking at the complexity of unknown ranges and valleys to the south aroused in us the desire to return and explore. Investigation showed that this region was blank on the maps. The excellent contoured sheet of the Geological Survey (1926) does not extend the range south of Earl Grey pass; nor does the map by A. A. McCoubrey (1928) carry it beyond the Toby and Hamill groups. Maps issued by the British Columbia Department of Lands are considerably older, and while they show very well the lower portions of all major streams of East and West Kootenay, the upper portions are incomplete and the watershed is not indicated. Recent sheets of the Standard series contain no additional information.[2]

The western drainage from the portion of the Purcell watershed under consideration is entirely to Kootenay lake. On the eastern slope it is to the Columbia river and, south of Canal Flats, to the Kootenay river.[3] The northernmost tributary from the Purcell watershed to the southward-flowing Kootenay is Findlay creek. Hence there is a point on the Purcell watershed which forms the apex of a triple divide between the Columbia and the Kootenay rivers on the east, and Kootenay lake on the west. To reach and identify this point which we regarded as the actual source of the Columbia, and to extend our knowledge of the main watershed, was the object of an expedition undertaken by the writers in 1930. We were fortunate again in having Conrad Kain as our guide and outfitter, and brought with us Peter Kaufmann, of Grindelwald, a guide whose

[1] *American Alpine Journal*, i, 68.

[2] In preparing the map accompanying this article the writers obtained basic information from the following sheets: Map 44, Duncan River (1913), and Map 4G, Windermere (1914), Degree Series, British Columbia Dept. of Lands; Windermere (1926), accompanying Publication 2070 G.S.C., Dept. of Mines; Windermere (1928), by A. A. McCoubrey, Winnipeg. All of these are on scale 1 : 125,000. Also Kootenay (1924) and Calgary (1925), sheets 19 and 20, Standard Series, National Resources Intelligence Service, Dept. of the Interior. Scale 1 : 500,000.

[3] In 1887 the head of Columbia lake was connected with Kootenay river by a canal which "turned the Selkirks into an island." The original reason for the project was a reclamation scheme to prevent flooding of land in the lower Kootenay valley by diverting the Kootenay river into the Columbia, a plan effectively nullified by the Canadian Pacific railroad which secured provisions allowing only a small navigable canal provided with locks. See W. A. Baillie-Grohman, 'Fifteen Years' Sport and Life in the Hunting Grounds of Western America and British Columbia' (London, 1900). Two other early books on the Kootenay region are: J. A. Lees and W. J. Clutterbuck, 'B.C. 1887—A Ramble in British Columbia' (London, 1888); and Mrs. Algernon St. Maur, 'Impressions of a Tenderfoot' (London, 1890).



Sketch-map of the Purcell Range and sources of the Columbia river

father and uncles were well known to Canadian climbers more than twenty years ago.

Through the lower 6 miles of Dutch creek, between Columbia lake and the junction of Brewer creek, there is a pack-trail. The Hawke ranch lies in the angle between the two creeks, with a beautiful view of the Rockies across the Columbia valley, and is reached direct by road from Invermere. At the ranch the valley of Dutch creek makes an abrupt bend to the south-west for some 7 miles, where it receives the water from Deer lake.

The Rocky Mountain trench is one of the most remarkable orographic features of North America. The two largest rivers of British Columbia, Columbia and Fraser, originate in it, leave it as soon as possible, and reverse their direction of flow. Dawson[1] has shown that in remote geological time the Columbia–Kootenay depression was occupied by a river which flowed southward. Evidence of this is found in the angles at which the lateral streams enter the Columbia, and the fact that the Purcell streams from Dutch creek to Spillimacheen river have ancient deltas tailing off to the south. This is especially well shown at the mouth of Dutch creek, at the north end of Columbia lake. It may be, as J. N. Collie[2] has suggested, that the Columbia river at that time had its chief source in Bush river.

We arrived at the Hawke ranch on July 18, driving out from Invermere in a motor-truck with our dunnage and meeting Kain, who had gone ahead with the horses. Dr. Hawke, a veterinarian, raises beef-cattle and uses the valley of Dutch creek as far as Deer lake as a range. He also breeds foxes, and has one of the best-kept farms in the Columbia valley. We were entertained hospitably, both he and his wife being interested in our objective, as the upper reaches of their valley are quite unknown to most of the local people.

On July 20 we continued with the packtrain. There is a good trail on either side of the creek as far as Deer lake, an enticing sheet of azure water where good fishing is to be had. Trail on the east side of the creek continues through a pass to the lower part of Findlay creek and on to the Skookumchuck, a route parallel to the Kootenay valley. Above Deer lake the valley of Dutch creek makes another abrupt turn, of more than a right angle, extending westward for 14 miles to the junction of a stream on the south side of Coppercrown Mountain.

From the Hawke ranch we had ascended a broad terraced valley, with the stream not far below. Above Deer lake the valley narrows, the creek swings through a winding gorge in cascades and falls, with little rock canyons sometimes bridged by fallen trees. The trail enters a forest, once swept by fire, and there is much cutting to be done in the windfalls before the horses can pass. The ground is carpeted with red bearberries and patches of magenta fireweed; there are tufts of white wool in the scrub evergreen where the trails of wild goat cross our path. Then we come into primeval timber, gigantic cedar and fir, with ferns and white-flowering devil's club beneath. Many of the trees have notches and inset slabs of old marten-sets; and, between the smaller pines, still older deadfalls, signs of winter trap-lines.

We crossed the sparkling torrent of Benabel creek, and passed a trapper's camping-place where the bleached skeleton of a lynx was swinging from a

[1] Dawson, *loc. cit.*, 81.

[2] 'Climbs and Exploration in the Canadian Rockies' (London, 1908), 231.

Sketch-map of the Purcell Range and sources of the Columbia river

tree limb. At the end of a long day we placed our camp beside an ancient log cabin, a filthy shack, but doubtless a welcome shelter in time of winter hunting. Our tents are at the edge of the forest, with only a thicket of willow and alder between us and the creek. The water throws a roaring cascade between immense granite blocks; our fire is lighted and the smoke rises lazily into the tree-tops. The packer is splitting clear white wood with rhythmic strokes of his axe, as if the windfalls earlier in the day had been a mere nothing. A tiny brown weasel with white vest comes up bravely to search discarded meat tins for scraps.

An old mining trail runs part way up the valley below Coppercrown. We left the horses at camp and followed this on July 21, the lower, open portions of the path giving us occasional glimpses of mysterious snowy peaks far to the south, where we now knew the source of Dutch creek must be. We continued through alder slides to high meadows and snow patches and reached a shaly pass just above timber line. To our surprise we found ourselves considerably east of the main watershed, looking down into a southern branch of Toby creek, with Mount Toby, and peaks that we had reached two years previously, rising beyond in the west. We used this pass as our first station in a compass survey. Its elevation by aneroid, considering the Hawke ranch as 3600 feet, is 8030 feet.

On the following day we again followed Dutch creek with the packtrain, sending Kaufmann and Rennenkampp, the packer, ahead with axes and saw to clear the trail. A mile or so above our camp the Coppercrown stream, flowing through a tangle to tree trunks, joins Dutch creek, the main valley making its third acute bend to extend due south. Two miles farther the packtrain crosses a stream, known to trappers as Slide creek, and the trail rises sharply into the forest, passing another log cabin. Beyond this the path is not always easy to find. There are signs of winter trap-lines, where men have passed on snow-shoes, but the cuttings are old and blazes few and far between. The horses force a way through slides of alder and willow; occasionally there is an open meadow, but more often we are again in the forest with axe strokes resounding and dead branches cracking as the packed animals pass along. Sometimes we are close to the stream; at others the bogs in the valley bottom force us to the game trails of the side hill.

That evening we reached a fork in the main stream, crossed and camped in the angle. As we unloaded the horses we looked across at a slide which we had crossed not more than thirty minutes before. Out of the willows there rose an enormous grizzly bear. Less than 300 yards away he looked gigantic, standing upright and looking at us with curiosity before moving off slowly in the opposite direction. Earlier in the day we had seen the remains of a buck deer, nothing left save the hide, the velvety horns, and broken bones.

A choice was now presented to us. A clear stream came from the south, while a larger volume of water, yellow with silt, joined it from the south-west, maintaining its identity of colour for a quarter of a mile beyond. Conrad, after some search, found trapping signs along the clear branch and decided that it would be the better way for the horses. Accordingly on August 23 two axe-men were again sent ahead. All day we worked, in the woods, in and out of bogs, up and down cutbanks, crossing and recrossing the stream which, although now

Snow slopes of Trikootenay glacier head of Dutch creek

Dutch creek below Trikootenay glacier

Trikootenay Peak from the Findlay basin

Mount Morigeau from the Findlay snowfield

small, was still swift and deep. The meadows were loaded with silt deposits, and the stream broke into several divisions. There were places where a branch might be only 3 feet wide, but it would have a bank 2 feet above the water and a bottom 3 or 4 feet below; dangerous for burdened horses. By evening we had made between 4 and 5 miles, and claps of thunder and flashes of lightning were sufficient warning. We raced the horses to the edge of the woods and made camp. We had long before passed beyond any signs of trail or trapper. The horses could be taken no farther without losing much time in making trail; we were at the head of the valley and slopes of trees in dense stands rose sharply to the craggy amphitheatre of the southern skyline. The remaining distances must be made on foot.

Conrad, wise woodsman that he is, would have nothing further of the valley-floor. Next morning he found a bear-trail for us that led up and up the hillside, through ferns, and over mossy logs still slippery with frost; a path that took us across a little saddle in the mountain's shoulder and down again through the trees to a bend in the stream. Here again we found a fork, and chose always the branch coming from the south, following it up the margin of a narrow rocky canyon where the little stream foamed and sprayed. The wet underbrush soaked us thoroughly, but at last we came to timber line, where the last larch trees gave way to a carpet of white heather and crimson painter's brush, and hoary marmots sunned themselves on the rocks beside the baby Columbia river.

The water comes down from all points in the broad cirque, in bubbling brooks and waterfalls below patches of melting snow. In the south-west corner there is tucked away a bare glacier, 3 or 4 square miles in area. Not long ago it was larger, and in it the river Columbia has its ultimate source. It was a thrilling moment when we reached it. We climbed up slopes of worn granite, crossed the ice to a rocky depression on its western rim and looked over into a deep, forested valley. To the north we saw peaks of the Toby and Hamill groups; this was the divide, the Purcell watershed, and beyond spread West Kootenay. The valley below us could be only that of Carney creek, which is the main branch of Fry creek,[1] entering Kootenay lake above Johnson's Landing. This was the solution of the unknown U-shaped valley we had seen from the Toby snowfield two years before.

Southward, for the first time since leaving the Coppercrown stream, we again saw snow-draped peaks that we knew must exceed 10,000 feet in elevation. Bearings were taken on the principal summits in view, this being the second station of our survey. The elevation is 8228 feet. As we trained the motion-picture camera on the glacier, Conrad pointed toward the slopes above. There, in line, were eight black-tailed deer,[2] two of them with enormous antlers. Slowly they filed down the ice, scarcely 200 feet away; then, startled by our sudden appearance, they began to race, and with enormous bounding leaps were soon out of sight. Their jumps are stiff-legged, in the manner of the African impala, and we measured 20 feet between some of the tracks in the soft snow.

We next walked up to a col in the rocky ridge bounding the glacier on the

[1] Dick Fry's ranch was situated near the present Bonners Ferry. In the early eighties this trader was the only white resident of West Kootenay.

[2] *C. columbianus*.

south, and looked over into a basin of meadows, lakelets, and rushing streams, the head of Findlay creek.[1] Opposite to us rose a gorgeous peak, sending a sweep of glacier into the valley and an ice-tongue ending below the larch trees, We recognized it as the mountain we had admired from the north, two years before. Mount Findlay is an appropriate name for it. Our viewpoint is the extreme westerly depression in the divide between the heads of Dutch and Findlay creeks. The Findlay snowfield is the largest glaciated area thus far noted south of Mount Toby, and contains about 5 square miles.

Kaufmann, in order to gain a better view along the ridge immediately to our right, scrambled to a little summit scarcely 400 feet above us. We have called it Trikootenay Peak, as it is the apex of the triple divide between the Columbia and Kootenay rivers and Kootenay lake. Its position is approximately lat. 50° 6′, long. 116° 27′, placing the glacial source of the Columbia river some 25 miles west and 4 miles south of Canal Flats at the upper end of Columbia lake. We estimate the total length of Dutch creek to its mouth at not less than 40 miles, 14 of which lie between Trikootenay glacier and the acute bend below Coppercrown Mountain.

By the time Kaufmann returned we had decided to attempt the ascent of Mount Findlay. We therefore descended a rocky couloir into the grassy slopes and walked along benches of moraine to groves of larch that border the northern margin of the glacier. Putting on the rope at the edge of the snowfield we continued a rising course through an icy corridor, winding past large crevasses to gain the southern rim. The snow became steeper and led us at last to the solid granite blocks that make up the peak, the summit being reached after another half-hour of enjoyable climbing.

Mount Findlay appears to be the loftiest peak of the southern Purcells, the aneroid reading 10,786 feet. Bearings were taken on prominent points, this being our third survey station. We looked again into the wooded valley of Carney creek, whose terminal branches extend north and south for a surprising distance. A snowy peak, which we named Mount Pambrun,[2] rose not far to the west, exceeded in elevation only by Mount Findlay, and behind it a misty gorge which contains Kootenay lake. Not many miles to the south-west rise a group of pinnacles, with an outstanding dark peak cleft like scissor-blades, a massif which is near the source of St. Mary river. Immediately below us on the south another branch of Findlay creek contains a lake, partly frozen over and with icebergs bobbing and gleaming in blue open water. Behind it hanging glaciers descend from two sharp rock peaks, of which the westerly is on the watershed extending southward from Mount Findlay.

To reach camp by nightfall was the considerable task confronting us, and an impending change in the weather made it evident that a night in the open would be uncomfortable. We recrossed the ridge to the head of Dutch creek and were down in the edge of the woods as a torrent of rain deluged us. But by the time

[1] Possibly named for Jacques (Jaco) Raphael Finlay, a well-known hunter and trader on the Upper Columbia in the days of David Thompson.

[2] Pierre Chrysologue Pambrun—born near Quebec in 1792; in charge of Fort des Babines in New Caledonia in 1825; travelled up the Columbia and across Athabaska pass with Edward Ermatinger and David Douglas in 1827; in charge of Fort Walla Walla from 1832 until his death in 1840. See J. Tassé, 'Les Canadiens de l'Ouest' (Montreal, 1882), ii, 299.

Trikootenay glacier (extreme left), Trikootenay Peak, and Mount Morigeau from Saffron Peak

Black-tail deer on Trikootenay glacier

Mount Rowand from the Purcell watershed south of Saffron Peak

Low pass south of Saffron Peak

we reached the bear trail leading to the tents the storm had passed and the sun was gleaming on the misty peaks above us. The cloudburst had served the purpose of driving us on, and to our surprise we regained the camp fire just four hours and a half from the top of Mount Findlay.

Our last climb was made on July 27, a day of rest and a morning of storm having held us in camp. It was cold, and at night water in the pails became surfaced with ice. We again followed the bear trail, which by now had become a blazed highway, striking up a branch of the stream coming from the west. Our objective peak was the highest at the head of the south-western fork of Dutch creek. We came to a low timbered pass on its southern side, leading across the watershed. If a trail were cut through the valley of Carney creek it could be made possible for horses. The pass was crossed to a point several hundred yards on the West Kootenay side, from whence we climbed through scrubby bush to the southern ridge of the mountain. We reached its crest, preceded by a herd of twelve white goats, all of them regarding our progress with unbounded amazement. Then, without necessity of roping, we walked up a sharp, rising granite ridge, built in places like a staircase, to a pinnacled summit.

Bearings were again taken, this being our fourth and last survey station. The aneroid read 10,018 feet. A fortunate break in the clouds to the north-east allowed us to take the angle of Mount Assiniboine in the Rockies. Below the northern face there is a small glacier with a terminal moraine of yellowish rock which loads the south-western branch of Dutch creek with colourful silt, on account of which we have named our vantage point Saffron Peak. The southern branch, from the Trikootenay glacier, is clear because of the meadows, bogs, and lakelets which filter out the debris. A little to the east, on a beach high above our camp, a small lake of opaque azure rests in a meadowed cup between the larch trees. We looked down on the forks of Dutch creek and followed the course of the winding stream treading north-eastward on its way to Columbia lake.

It is now possible to describe more completely the Purcell watershed south of Earl Grey pass. From the pass the water-parting extends southward for 2 miles, crossing the summit of Mount Toby and for 2 miles farther rounding the southern rim of Toby snowfield. It then runs south-easterly for a mile to a depression just above timber line, connecting the south fork of Toby creek with a branch of Carney creek.

For the next 3 miles the divide runs slightly east of south, crossing several minor summits and reaching a col between Saffron glacier and a branch of Carney creek, thence turning south-eastward for slightly more than half a mile, following the rim of the glacier and rising on the crest of a prominent outlying buttress to the summit of Saffron Peak. It then crosses the lower adjacent eastern peak and turns abruptly southward for a mile, dropping to the low wooded pass that connects Dutch creek with the central tributary of Carney creek. The course of the divide continues south for 3 miles, crossing a minor rounded summit and reaching the western margin of Trikootenay glacier, and Trikootenay Peak at its south-western angle. At this point the East Kootenay drainage transfers from the Columbia to the Kootenay river.

From Trikootenay Peak the watershed turns abruptly west for half a mile to a minor summit from which a great subsidiary ridge, with a snow-clad peak

which we have named Mount Rowand,[1] extends to the north-west into an angle of Carney creek. The divide itself follows a course of a mile and a half to the south-west to reach the crest of a higher snowy peak. This important summit we have named Mount Morigeau.[2] The water-parting, which is now rounding terminal branches of Findlay creek, extends just west of south for a mile and a half to its high point on the summit of Mount Findlay. It then sends a narrow descending ridge to the south, which crosses, some 4½ miles beyond, the westerly of two prominent rock peaks also at the head of a branch of Findlay creek. The West Kootenay drainage thus far is still to Carney creek. The divide near this point crosses lat. 50° and bends acutely to the south-west to pass the heads of Skookumchuck creek and St. Mary river, over or near the pinnacled massif observed from Mount Findlay. The air-line distance from Mount Toby to Trikootenay Peak is approximately 10 miles; from Mount Toby to Mount Findlay 11 miles. These distances along the watershed are 12½ and 16½ miles respectively. Later observations showed that Mount Findlay, Mount Morigeau, Trikootenay Peak, and Saffron Peak are visible from points in Dutch creek valley below Coppercrown Mountain, the greater elevation[3] of the peaks on the head of Findlay creek making them visible above the lower bounding ridge of the Trikootenay cirque.

Thus the last problem was solved. Two days of hard riding brought us to the Hawke ranch on August 29, and on the following day the truck carried us to Golden in time for the express train westward. In the evening we crossed the Columbia at Revelstoke, a placid, broad, smooth-running river, contrasting with the rushing stream we had left that morning. In this modern day it would be rash to make claim of discovery. Some unknown trapper or prospector may have ventured in bygone time to the very head of Dutch creek. But Conrad Kain, whose opinion in the woods is to be taken with respect, could find no cuttings or signs of trapping in the last few miles of the valley. Our party is apparently the first to determine the length of Dutch creek and to establish the geographical position of the glacial source of the Columbia river. We have added 20 miles to the known watershed, south of Earl Grey pass, between East and West Kootenay. Beyond all this we have gained memories of the exquisite mountain landscapes of the southern Purcell Range.

[1] Dr. John Rowand—born at Fort Augustus (Edmonton), his father having entered the North West Company about 1800; graduated at Edinburgh; accompanied Sir George Simpson in 1841–42, from Edmonton to Honolulu, on the latter's journey around the world; at Red River, York Factory, and Fort Carlton in 1846 in the course of medical work; died at Quebec in 1889. See E. Coues, 'Henry-Thompson Journals' (New York, 1897), ii, 602.

[2] Morigeau—the head of the family came from the St. Martin district of Montreal and settled near the source of the Columbia river about 1819. Father De Smet found him there in 1845 and baptized the family. See H. M. Chittenden and A. T. Richardson, 'Life, Letters and Travels of Father Pierre Jean De Smet, S.J.' (New York, 1905), 51.

[3] The relative elevations of peaks on or near the watershed, named by us, appear to be in descending order as follows: Mount Findlay, Mount Pambrun, Mount Morigeau, Mount Rowand, Saffron Peak, Trikootenay Peak. We believe that Mount Findlay is higher than Mount Toby by a considerable margin and is the loftiest peak of the range south of Earl Grey pass. The pass below timber line on the southern side of Saffron Peak is at least 500 feet lower than Earl Grey pass. It is not only one of the lowest crossings of the main Purcell watershed, but also the only pass that could be made feasible for horses between Dutch creek and West Kootenay.

TWO NOTES ON SINKIANG

LIEUT.-COL. REGINALD SCHOMBERG, D.S.O.

I. The Tuga pass over the Barköl Range, Eastern Tien Shan

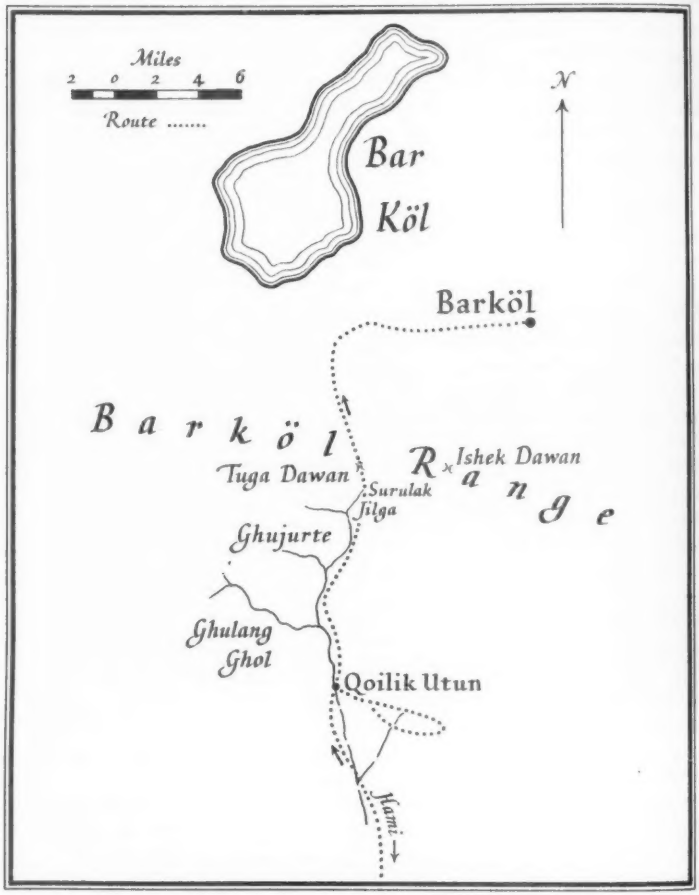
THE Tien Shan, east of Urumchi, the capital of the province of Sinkiang, falls into three well-defined sections, clearly visible and distinct to a spectator viewing the range from a distance. There is in the west, above and north-east of Urumchi, the Bogdo Ola, with its high central peak of Bogdo San and its small lake. At the eastern end of this massif is the remarkable gap or pass between Taoshui (not shown in the Survey of India 1/500,000 map), which is 18 miles south by east of Tashihto, and Chikuching, a small oasis on the southern slopes of the mountains. The Barköl Range rises gradually from this depression, then falls somewhat to a point north-west of Hami or Qomul, where the final section of the Tien Shan culminates in the Qarlik Tagh or Snowy Mountains, that smooth, almost level crest of snow and glacier that lies above the oasis of Qomul, marking the end of this great mountain range in the east. Beyond is the dreary and desolate Gobi.

Standing between the stately massifs of Bogdo Ola and the Qarlik Tagh, the Barköl Range looks somewhat insignificant, although the actual altitudes do not greatly differ. This range, seen from the south, presents a monotonous line of stark and sterile hills, unrelieved by vegetation, and with little promise of what the interior holds. The northern sides, on the other hand, are very different, as they are clothed with thick forests of conifers, and are truly Alpine in character. None of the passes over the Barköl Mountains are possible for carts, which have to go round by Chikuching. There are however several tracks across the mountains used by the local inhabitants, of one of which this account is given; the route illustrates the deceptive nature of all Central Asian scenery, and indicates to some extent the water problems in that area. The important passes in the range are the Tuga, or Camel Pass, and close to it, on the east, the Ishek, or Donkey Pass. The names give some clue to the difficulties of the passes, but the first pass is but seldom available for camels, whereas the second is more often passable by donkeys. From the outside the approach to the mountains is uninviting, with a dismal stretch of rising plain, stony and dry, and the wide, shallow watercourses, scantily fringed with desert vegetation, so well known to and so detested by every traveller in Turkistan.

It was thus that we approached the foothills in March 1928, hoping, early though it was, that we should be able to struggle through the snow. The Qomuliqs were polite but protesting. We were deluged with dissuasion, and we could not make the people understand that a long, roundabout, dull route did not strike us as in any way attractive. But these choruses of disapproval are known only too well to any one who has ever tried to leave the beaten track in the East, and we disregarded them, firmly stating that we meant to go by the Tuga pass.

On reaching the foothills we halted at the prosperous village of Qoilik Utan or Utun, presided over by a Qurban Niaz Beg, one of the twelve *begs* in charge of the mountainous districts of the Khanate of Qomul. Behind this settlement was a long narrow gorge, with a stream of clear water that at once lost itself in

the desert. On a brilliant day in early spring we plunged into this ravine, and as we wound up the densely wooded gorge we realized how deceptive appearances were. Out of sight from the plain were forest-filled glens, with stretches of pasture and budding flowers; yet a glance behind showed us the shaking



Col. Schomberg's route across the Barköl Range

mirage rising from the waterless plain. It is always a source of wonder how such abrupt contrasts can exist so close to each other.

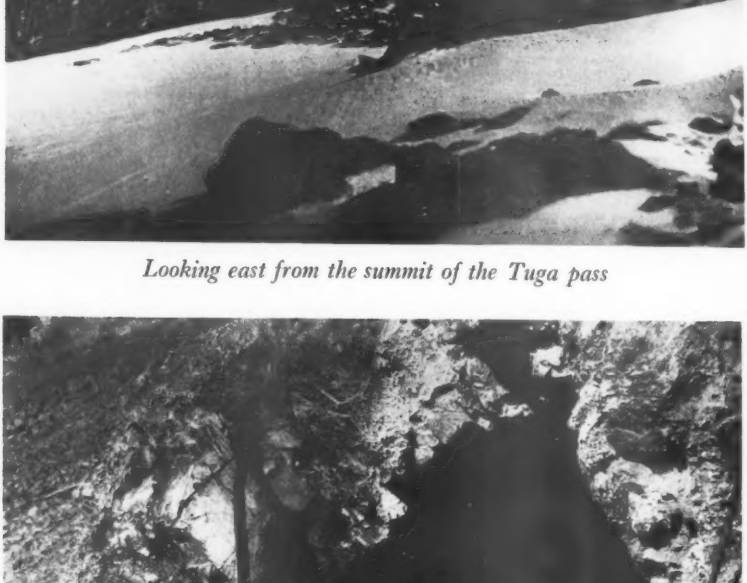
The "Aq Terek," or white poplar, often mistaken for the chenar of Kashmir, was very abundant. The growth of the trees testified to the favourable conditions of the climate, as most of them were 50 to 60 feet high, and a few in favoured places as high as 80 feet. The willow was very plentiful, with other

Foothills of the Barköl range from the south

Approach to the Tuga pass from the south

From the Tuga pass looking north towards Barköl
(*The diagonal line is a photographic defect*)

Looking east from the summit of the Tuga pass



Solfatara on the Zemish Tagh

undergrowth, and the track was often difficult to follow. After 5 miles up the narrow glen the tall precipitous black sides ended, and the main valley turned off west in the well-wooded Ghulang Ghol, with two prominent peaks at the head. The path to the pass now turned north-east, passed a patch of cultivation with a ruined house, and led up the defile of the Tang-i-tar, where there was just room to squeeze through. Then suddenly the trees ended and the track ascended a widening valley into the grazing area of Ghujurte, which even at this early season supported large herds of sheep. We had now reached a fairly Alpine country, and 10 miles from Qoilik Utun brought us to the Surulak Jilga, where the snow was deep, and the ponies ploughed through with difficulty. Although we were still on the south of the range, where the rainfall is less than on the north, the pine forest was thick and extensive and the trees were well grown. The northerly aspect of the wooded slopes favoured the growth. The track was still awkward, as we pushed through the heavy snow on the hillsides with nothing to guide us. At length, 14 miles from our starting place, the top of the Tuga pass was reached. The height was approximately 8500 feet. To the right and east the Ishek pass was visible a few miles away, and appeared to have more snow on it than did the Tuga. It would seem that the Tuga pass is identical with that marked "Koilak Otun" in Mr. Douglas Carruthers' map in Volume II of 'Unknown Mongolia.'

The view from the pass was exquisite on this enchanted day of early spring. Not a cloud flecked the serene sky, not a breath of wind stirred, and the Barköl lake lay at our feet studded with ice-floes and with strange ribbons of blue water crossing it. To the east was the town of Barköl, with the Metshin Ola beyond, and to the north-west was a tumbled mass of low, barren hills, contrasting with the dark larches that streamed down the hillsides from the top of the pass.

Although the town lay near enough to spit on, as the men said, we had to hurry from this lovely view, for the day was short. We scrambled down the face of the hill very steeply, and then plunged into forest with the snow piled in drifts. Our progress was slow, the evening was coming on, and great care was needed to prevent the tired ponies from falling into the bed of the valley below. Suddenly the forest ended and we were in the barren environs of the lake. The town was hours away, and we should have liked to halt, but there was no water and little fuel, though only a mile or so above was the snow and the trees. At last, after a tedious but interesting day, we arrived at the town, having been fifteen hours on the road. The magistrate at Barköl most courteously allowed the gates to be opened for us, for it was pitch dark and long after closing time. We were thus saved a very cold night on the snow outside the city walls among the dead dogs and garbage; and we found a comfortable house belonging to a very disgusted Turki merchant, who resented the arrival of his fellow Moslems, but had to make the best of it.

Barköl is a dreary town, truly described by Mr. Carruthers as a town of stagnation, and a stagnation too that has increased of late years. Caravans no longer come by way of Barköl. It is at a dead end, with no attractions at all. The climate too is famous for its severity, exposed as the town is to the blizzards of Zungaria. The place abounds with temples, both within and without the walls, but many are neglected, and the appearance they present adds to the

desolate aspect of the place, with its crumbling walls and derelict spaces. The environs are more agreeable, and the forests running down to the town, the pale lake with the barren hills beyond, and the Chinese farms lining the slopes of the Metshin Ola attract the visitor to make a longer stay and explore the surroundings of this little-known place.

The Barköl Mountains remain quite unvisited. They have much to attract, and the Qomuliqs are always friendly and helpful. The grazing is good, and the scenery pleasant, but nowhere really grand. There is a complete absence of big game on the south side, and the same will soon be true of the north. Bird life, too, is somewhat scarce. The chief charm of the mountains lies in their situation between two deserts; the views offer unfailing contrasts at all times. The distance from Qoilik Utan to Barköl town was 32 miles.

II. Solfataras in the Kucha District

In many of the older maps of Chinese Turkistan a volcano is marked in the neighbourhood of Kucha, but there appears no explanation of how this mysterious mountain ever found itself on European maps. Perhaps it was due to a muddle similar to that caused by the red sandstone hills of Turfan being called the "Fire Mountains" by the Chinese, which led Western geographers to expect volcanic traces in that area. Travelling up the Kucha river in November 1928, I heard reports of mining and factories—an unusual combination in Chinese Central Asia—and so went to see what the rumour meant. Crossing a high ridge of red sandstone above the village of Kan, and passing under cliffs and bluffs, we went through a narrow defile and found ourselves on the right bank of the Kucha river, here a broad bed with very little water at this time of the year. Opposite, huddled under a cliff, was the squalid village of Zemish Tagh or Alum mountain, and behind, barren and ugly, was the Alum mountain itself. The word "Zemish" or "Zamuch" means alum in Turki. The pronunciation in the Kucha district was always with "sh" and not with "ch." The alum was dug out of the hills, boiled in large cauldrons in the open, and then run into shallow troughs, where it crystallized on twigs placed on the surface of the liquid. The coal to heat the furnaces came from the hill behind. Although everything was done in a simple, not to say primitive, fashion, the result was pure, clean alum.

More interesting however were the solfataras visible on the hill above. I counted eight of these, visited several, and was told that there were more. In the cool morning air before the atmosphere had become hot, their vapour was clearly seen from a good distance. Most of the solfataras were cracks in the ground, from which a good deal of vapour and a little trickle of water issued. The surrounding soil was much impregnated with sulphur. The largest (illustrated) was partly in a cave and partly outside, and the heat was so great that it was only just possible to enter. An apple was roasted in four minutes. The Turki with us dug down outside the cave and turned up a number of stones covered with clean sal-ammoniac crystals. This is the *nashurde* of the native, much valued as a drug. In his efforts to dig out the stones the man burnt himself at a depth of 18 inches down, which shows how very hot the ground was. Besides the encrustation of ammonia there was a good deal of sulphur deposit, and the smell of it was strong.

It seems that these evidences of volcanic action may have led to the belief that there was a volcano in the neighbourhood, and the smoke seen from a distance does give ground to the idea. Curiously, there was no sign of a hot spring, and the small trickle of water, probably due to the melting of a recent fall of snow, was not a permanent spring, but infiltration.

MASTER HORE'S VOYAGE OF 1536

PROFESSOR E. G. R. TAYLOR

THE account published by Richard Hakluyt in the 'Principal Navigations' of a voyage of Master Hore and divers other gentlemen to Newfoundland in 1536, a voyage in which, although it lasted but six months, one participant at least claimed to have been so altered by hunger and misery that his own mother did not know him, has always aroused a certain degree of scepticism. Hakluyt, it will be recalled, obtained the story in part at first hand from Thomas Butts, son of one of the Royal Physicians, and in part at second hand from reminiscences given at a much earlier date to his cousin of the Middle Temple by Oliver Dawbeney, another participant in the voyage. These reminiscences included a gruesome account of starvation and cannibalism on the part of the ship's crew. Now Thomas Butts must have been at least seventy years old when Hakluyt visited him to obtain material for his collection of voyages, and he was recalling events of half a century earlier. Dawbeney, save for this early adventure, spent his life in humdrum Civil Service appointments at the Irish Mint and the London Customs House. The stories of both would thus in all probability be highly coloured and inaccurate in detail.

A laborious search at the Public Record Office for contemporary evidence of the voyage has proved successful, owing to the accident that a suit was instituted against Richard Hore in the High Court of Admiralty within six weeks of his return. The relevant legal documents, six in number,* yield no details of the incidents of the voyage, but they indicate its purpose and achievement, simply the capture of Newfoundland fish. The leader of the expedition, Richard Hore, was a citizen of London and a leatherseller, who had chartered a ship, the *William of London* (not the *Minion*, Hakluyt must have misheard the aged Thomas Butts), owned by William Dolphyn, a London draper. According to the latter's deposition the voyage was appointed to be "from the port of London to the place or land called in English the Newe found land in the most remote parts."

The *William*, according to her owner's statement, set out in April and arrived safely in Newfoundland, where Richard Hore "caught fish, or caused them to be caught." The return voyage was also made in safety, the ship arriving in the Port of London in "September or October," that is to say at the end of the one month or the beginning of the next. Hore failed to carry out the terms of his contract, and hence Dolphyn obtained from the Court an order for the arrest of the cargo of "fish and other goods" that was on board. The case was before

*H. C. A. Series 24, No. 2, and H. C. A. Series 30, No. 542.

the Court early in November 1536, and Butts' mention of the *Trinity* as the second ship concerned is confirmed by two notices relative to her arrest docketed with the *William* papers.

That Richard Hore was a man of few scruples is indicated by his adventures in 1537: he chartered a fresh ship, the *Valentine* of London, and took her to Spain, subsequently taking on board at Lisbon a number of Portuguese whom he undertook to convey to London. Instead of doing so, he took them to a small haven near Cardiff, and holding them prisoners, attempted to extort a large sum of money from them. For this he was brought up before the Earl of Worcester at Cardiff Castle, when he protested his loyalty and innocence. A year later (September 1538) the *Valentine* was arrested at the instance of Sir Thomas Spent (apparently her owner) to whom Hore owed £280. Her cargo of salt and wine was sold, although doubt was expressed as to whether it had been honestly come by.

Meagre though this fresh evidence as to Hore and his voyage may be, it serves to indicate that the major hardships alleged in the accounts received by Hakluyt must have existed merely in the minds of the narrators. Hore planned an ordinary commercial venture to the Grand Banks, and had the wit to combine it with what looks very like an excursion for tourists. Only a year or two earlier a Brazilian chief, in full savage war array, had been exhibited at Whitehall, and it is not to be wondered at that much talk of the strangeness of the New World and its "Naturalls" excited among the younger gentry of London a desire to see for themselves. To gratify their curiosity it must have been necessary, once across the Atlantic, to leave the beaten track of the Banks fishermen, and it is quite probable that the visits ashore resulted in a temporary absence of the comforts and even the necessities of life. There was too little time for any real exploration, and not one of the documents hints at any unusual happenings; nor has any confirmation of the story of the plundered French ship come to light, although it is in accordance with Hore's character that his cargo of fish may have been stolen. Nevertheless, an ordinary voyage to Newfoundland involved what must have seemed great wretchedness to a company of gently nurtured men, accustomed to the softness and ease of London court and legal circles, from which it appears they were almost all drawn. Little wonder that they left the ships at the first possible moment at St. Ives, and finished their journey by land, instead of facing the choppy waters of the Channel.

It is said that one of them, Armigel Wade, afterwards Clerk to the Privy Council, wrote a book on his experiences, and hence gained the reputation of being the first Englishman to see the New World; but no trace of such a work is to be found. He and his fellows, however, deserve their place in history beside the Brothers Parmentier and Pierre Crignon, as among the first to travel abroad not for gain but for aesthetic and intellectual pleasure.

REVIEWS

EUROPE

DIE OSTALPEN. By JOHANN SÖLCH. *Breslau: Ferdinand Hirt* 1930. 8×5 *inches;* 116+20 *pages; illustrations and maps. M.*3.50

This booklet is based upon extensive personal knowledge of the area concerned, the author having spent long periods of time in the towns of Vienna, Graz, and Innsbruck, and used these as centres for various excursions and observations. Necessarily however in view of the limitations imposed by membership of the German *Jedermann* series, the book must deal primarily with known facts, so that comment can only be directed towards selection of material and methods of presentation. There is no doubt that the subject is one which it is very difficult to treat briefly and clearly in a small space, and it is interesting to note the author's attitude towards the problems involved. They have of course been greatly complicated by the drawing of the new frontiers. Of these we need say nothing beyond expressing the opinion that a geographer, writing in that capacity and with a restricted space at his disposal, should so far as possible limit himself to facts, leaving political topics for another occasion.

These new frontiers make a very precise definition of scope essential if the book is to be fully intelligible to the general reader. The author in his opening sentences defines the Eastern Alps somewhat summarily by a passing allusion to the Rhine-Splügen furrow and the north-eastern extremity of the Alps near Vienna. But, apart from the other limits, we have on p. 23 a statement about differences between the "Swiss" Alps and the Eastern Alps; on p. 75 it seems to be implied that the Alps of Grisons generally are "Eastern," while the geological map shows a "Western Alpine Transition Zone" of which nothing appears to be said in the text. While fully admitting that such minor inconsistencies are difficult to avoid, one cannot but wonder if the ordinary reader, however carefully he reads the book, will be able to form a perfectly clear picture of the limits of the area treated. Similarly, those who are concerned with the purely pedagogic problem of how far the geographer, as such, should deal with the facts and theories put forward by the structural geologists, will find the author a little evasive. There is a generalized geological map and also a section after Kober, but the treatment of tectonics in the text is both sketchy and unrelated to the somewhat minute topographical detail which forms the body of the book. This absence of explanatory interrelation between structure and topography is particularly noticeable in regard to the two great longitudinal furrows on which much emphasis is laid in the text, though, unfortunately, no general map and no sketch-maps of critical areas make their significance clear.

Such points however are mainly of importance to the *Geographen von Fach* to whom as well as to *Jedermann* the author makes his appeal. The latter will find a great mass of interesting detail, illustrated by sketch-maps and many striking reproductions of photographs; a useful bibliographical note is added. M. I. N.

THE LAKE DISTRICT (SOUTH) REGIONAL PLANNING COMMITTEE. Report upon the Survey and the Regional Planning Scheme. By R. H. MATTOCKS. *Kendal: Atkinson and Pollitt* 1930. 12×10 *inches;* x+68 *pages; illustrations and map*

This Report refers to an area of over 190,000 acres in Westmorland, an area lying mostly east of Windermere but which includes the districts of Great and part of Little Langdale, Grasmere, Rydal, and Ambleside. The Report includes in Part I a brief historical survey of the region and an account of present conditions.

In Part 2 are set forth the proposals of the Regional Planning Committee for the future guidance and control of man's activities within the area.

The most important of these proposals deal with the control of the distribution and density of buildings. This is to be attained, it is suggested, by the division of the whole region into zones within which building is to be prohibited or permitted only under restrictions of varying degrees of severity. Thus, referring to the Lake District, all the higher lands about Great Langdale, Easedale, Grasmere, Rydal, and Ambleside are to be scheduled as "Open Spaces," as are various eminences and good view-points in the neighbourhood of Bowness and Windermere. Certain parts of the lower land should, it is suggested, be similarly kept untouched, such as a belt along the Rothay and Easedale becks at Grasmere, where Loughrigg slopes down to Rydal Water, at the head of Windermere, and between Low Wood and the lake. At the opposite extreme from these permanent open spaces are the islets of population in the dales, most of which are to be provided with an adjoining area over which they can expand but in which houses must be restricted to at most twelve per acre. At Grasmere, for example, a belt along the lower slopes of Rydal Fell is to be set aside as "residential, low density," together with the west side of the lake and a strip encircling the base of Helm Crag. Between the "Open Spaces" of the fells and the dale settlements are areas where buildings, other than agricultural ones, are to be more severely restricted than in the "residential" zones, not more than one house to three acres being anywhere permitted here, and in some parts the limit being a house to a hundred acres. Industries, if any, are only to be established in the zones of normal density of population and with the consent of the local Council. Powers should also, it is suggested, be sought to control the colour, material, and size of buildings, and it is rightly emphasized that insistence on the use of local stone and slate could cause little hardship in a country of such frequent quarries. Considerable attention is given in the Report to the traffic problem, and projected roads in the Windermere district and, among others, the by-pass roads designed to avoid Ambleside and the hill of Bannerrigg, between Staveley and Windermere, are discussed.

Those who see in Regional Planning a means of safeguarding beauty must find these proposals sound, though the policy advocated of spreading the tourist traffic over an increased number of roads is open to serious objection. Without some such scheme of control (and powers to enforce it are yet to be obtained) administered in the right spirit the Lake District must, with other rural areas, lose its unique individuality. Yet this organized attempt to "preserve" it has something dreadful about it. Perhaps it is because the reader of this Report becomes insensibly imbued with the feeling that the Lake Country can hope for nothing better than to become a show for visitors to stare at, a feeling partly due to lack of reference, in these proposals for the future of their ancestral home, to the native dalesfolk and their activities. The chief charm of the lakes and mountains is attributed in the Report to "their seeming aloofness from man's handiwork," and there is an alarming reference to the possible abolition of sheep grazing rights on the "Open Spaces" of the fells. It must be remembered that before the first visitors came there were as many farms in the Lake Country as the land could support, and that though the sheep farmers must suffer in any event as their limited and precious low-lying pastures are utilized for building, yet they may suffer more from the widely-spaced housing development advocated in the Report than from the growth of smaller and more crowded property. And any interference with their grazing rights on the common land of the fells would mean their extinction.

Farming in the Lake Country is as old as the history of the district and still as nicely adjusted to its environment as are the old houses, the old tracks, and the

Herdwick sheep on which depend the agricultural life of the region. It is at least as worthy of "preservation" as are the open spaces and the view-points beloved of tourists, and it would have added a touch of grace to this otherwise excellent report if some assurance had been given that where the claims of intending residents and those of the farming community clash, preference should be given to those of the latter. For, whether or no they have a romantic appreciation of scenery, the dalesfolk like all mountain dwellers love their own country deeply, compete eagerly among themselves for every farm that falls vacant, and would regard banishment from the Lakeland dales as a disaster beyond their imagination. E. M. W.

LIÉGE: étude de géographie urbaine. By P. Le Couturier. *Liége: H. Vaillante Carmanne* 1930. 10×7 *inches; 240 pages; illustrations and maps*

This geographical urban study begins with a general description of the site of the town at the confluence of the Meuse and the Ourthe, in the great coal furrow of the Sambre-Meuse, on the edge of the Hercynian massif. The author stresses the extension of the influence of industrial Liége over a transition zone which passes gradually to the purely agricultural regions of Hesbaye, Herve, Condroz, and Ardennes. He then proceeds to a detailed study of the site, dealing with the slopes of the three valleys which converge on Liége, the terraces and the alluvial flats of the flood plain, the régimes of the confluent streams, and works back (p. 52) to a consideration of the original position, on the little river Legia, which cuts a cleft into the plateau that overhangs the Meuse valley on the left bank and whose dejection cone appears to have decided the site of the town, rising as it did some 23 feet above the marshy flood plain and just beneath a fortifiable bluff of the plateau.

Chapter II deals with the archaeological finds relating to settlements which succeeded one another from early times, and traces the growth of Liége from a small village in the seventh century to a fortified city under the prince bishops, its extension along the Meuse valley and up the Legia, and finally a trans-Meuse settlement in the tenth century which was included in the fortifications in the thirteenth. Coal was being exported from the neighbourhood of the city from the end of the twelfth century. At the end of the thirteenth century Liége is "a well-developed urban centre, enjoying in the shelter of its fortifications and under the care of its princely chief an autonomous administration and peculiar privileges, and living mainly on its commerce and industry."

Chapter IV brings the story of Liége from the thirteenth century down to modern times, shows the rapid development of the coalfield with the introduction of methods of pumping, traces the sufferings of the town at the end of the eighteenth century from fire and bombardment, its rise to prosperity under Napoleon Bonaparte, who created the great cannon foundry and encouraged the development of the zinc industry. With the scientific inventions of the end of the nineteenth century, Liége took full advantage of its position on the coalfield and on important cross-roads, and with the establishment of the railways and the disappearance of the fortifications, began to grow rapidly. The river port developed an industrial suburb on the right bank, forcing the drainage and reclamation of the flood plain, and the town began to extend also on to the neighbouring heights.

The second part of the book deals with present-day Liége, describing the various quarters of the town, the distribution of population, and the type of housing. A map has been prepared, based on the census of 1920, showing the density of houses. This the author compares with a population density map, from which it would appear that in Liége, unlike most large cities, the centre is

more densely populated than the outer ring. The author proceeds to point out that this difference between Liége and other cities is only apparent, that open spaces and public and commercial buildings occupy a great part of the centre and that the crowded areas are confined to certain poor districts of the old town: facts which, one would imagine, might have been deduced from a large-scale plan with far less expenditure of labour.

Twenty-six pages are devoted to a description of the industries of Liége and the industrial population, and the author ends up with a list of public institutions, attractions for the tourist, and objects of commerce. A very simplified relief map of the town on a scale of 1 : 8125 is useful and clear, but it gives no names, nor does any other map in the book, at least legibly. H. O.

BETWEEN THE RIVER AND THE HILLS: A Normandy Pastoral. By SISLEY HUDDLESTON. *London: Harrap & Co.* 1931. 9×6 *inches;* 316 *pages; illustrations.* 12*s* 6*d*

To celebrate the superiority of country over town is a literary occupation as old as Horace. It needs a great writer to say anything fresh and significant on so well-worn a theme. Mr. Huddleston is an English journalist who has found his spiritual home in a charming corner of Normandy. There he has become in the course of the years more French than the French, an integral and accepted part of the life of his village. He has discovered the secrets not only of the countryside but of the country people themselves, a task requiring rare tact and adaptability. He views his neighbours with affection but without sentimentality. He quotes from his friend, Monsieur Pierre Vernon, some shrewd but not flattering remarks on the relative importance of formalism and faith in the religion of the French peasant.

In this book he attempts to convey some impression of his Norman home and the people among whom he lives. It is the sort of book which it is hard to do really well; and at first it may seem that the author needs a finer style or a more direct charm of manner to succeed in his attempt. His reflections on the emptiness of the busy town and the fullness of the peaceful country are neither new nor striking. And yet we gradually fall under the spell of his content; and at last something of the quiet and ecstatic happiness in which the author lives his life overflows through the channel of his undistinguished prose to calm and delight the heart of the imaginative reader. D. C. S.-T.

CORNWALL: A SURVEY OF ITS COASTS, MOORS, AND VALLEYS. Prepared by W. HARDING THOMPSON for the Cornwall Branch of the C.P.R.E. *London: University of London Press* 1930. 13×10 *inches;* xx+130 *pages; illustrations and maps.* 17*s* 6*d*

It is a pleasure to welcome another of the carefully prepared and tastefully produced C.P.R.E. Surveys. Again the bulk of the work has been done by Mr. Harding Thompson, and done, it is needless to say, in an admirably concise and orderly manner with the assistance of excellent illustrations and three folding maps of the Duchy on the scale of 4 miles to an inch. There is the now recognized division into two parts, the first describing Existing Conditions, and the second giving Recommendations, with ten chapters to each, one on the antiquities being contributed by Mr. Charles Henderson. In spite of anything that enthusiastic natives, like "Q" in the Preface, may say about the inland scenery it is the coast that is the special glory of Cornwall and the glory that is specially liable to be dimmed. Mr. Thompson takes us round it from headland to headland and from porth to porth, pointing out to us the amenities of each and the threats to those amenities. He gives a list of the principal danger-points; but is any part of the

coast safe from the despoiler? A single bungalow carelessly dumped down at the mouth of a combe can (and does) sully the charm of all that locality. How far more damaging is a barrack-like hotel planted four-square on a cliff-top! And the Cornish cliffs are not so high as to dwarf the works of man. There is a monstrous example at Tintagel of one of these "buildings in the wrong place" (the first of Mr. Thompson's categories of disfigurements). In fact, the whole village of Tintagel, a place that should have been the home of romance, is quite deplorable; the reader is warned not to be misled into supposing that the delightful "Old Post Office" of Plate XLI is typical of the buildings there. Tintagel comes in the centre of one of the three suggested national parks, which embrace the coastal areas from Cambeak to Pentire, from St. Ives to Pendeen, and from Land's End to Mousehole. The unique serpentine cliffs of the Lizard peninsula might well form a fourth. But there are few miles of the whole coast-line that could not claim "protection." Inland the chief precautions needed are those common to the whole country, that is, in connection with building materials, road design, advertisements, filling stations, and industrial undertakings generally. It is rather curious to find the ruined mining buildings of Cornwall acclaimed as historical monuments in the line of succession to cromlechs, Celtic hut-dwellings, and mediaeval castles. Who knows but that the red-roofed bungalow may ultimately take its place in that line? J. H. R.

EUROPEAN ENCOUNTERS: A Travel Note-Book. By HUBERT GRIFFITH. *London: The Bodley Head* 1931. 8×5 *inches;* xvi+307 *pages; illustrations and map.* 8*s* 6*d*

This is a first-rate piece of journalism. The author makes no claim to have penetrated profoundly into the national characteristics or international mysteries of Europe. He undertook for his paper a short journey through Berlin, Riga, Warsaw, Vienna, Budapest, and Constantinople, and kept his eyes open and his mind alert. If his observation is inclined at times to be superficial he brings to its presentation a freshness and vivid sympathy which make his book excellent reading. He has a mind and a temperament admirably equipped for this sort of travelling: he is tolerant, interested, amused; not unduly biassed by his political creed, and endowed with a love and real understanding of pictures, music, and the theatre. On this last subject, as a playwright and dramatic critic of originality and distinction, he is always worth listening to. It is a surprise to find so widely cultured a man attributing Wordsworth's familiar tag about art as "emotion recollected in tranquillity" to Walter Pater.

Nothing impressed Mr. Griffith more than the splendid new Municipal Working-Class Flats which Vienna has erected during the past nine years. At the end of the book he drops his mood of quiet observation and impersonal reflection, and launches into an impassioned attack on militarism. It is invigorating to find the champion of pacifism and disarmament as argumentative and as militant in his attitude as the most belligerent of the upholders of the *status quo*. D. C. S.-T.

ASIA

MEMOIRS OF A CEYLON PLANTER'S TRAVELS, 1851 to 1921. By MOUNSTEVEN BREMER. *London: Rivington* 1930. 9×6 *inches;* viii+282 *pages; illustrations and map.* 10*s* 6*d*

'Memoirs of a Ceylon Planter's Travels' is a book certain to be read with enjoyment. Mr. Bremer's keen interest in everything that he saw on his numerous journeys is communicated insensibly to the reader even when his descriptions and comments relate to places and facts familiar to most of us. The interesting

experiences of his early days on the Continent evidently inspired an attachment to continental life and peoples which has remained unaltered to the present day. On every occasion of return from the East some portion of his time was invariably given to renewing or extending his acquaintance with one European country or another. Mr. Bremer's pleasantly worded descriptions of his life in Ceylon during the early days of coffee planting give us not only a clear picture of the strenuous but not unattractive existence led by himself and his companions in the Island, but also an excellent idea of the place, its people, and its early conditions. The sound qualities which enabled Mr. Bremer at the age of twenty-four to adapt himself to his new life and surroundings were also no doubt instrumental in his being selected during the War for posts needing something more than the very useful knowledge of European languages which he must possess. The details of his journeys through India, Australia, Austria, Russia, Finland, Sweden, Canada, Japan, China, and the Malay States are given in an easy, descriptive style very attractive for the reader to follow. Mr. Bremer's purpose in writing an account of his experiences, namely a hope that a record of his own early efforts in making a career may be the means of inspiring some stay-at-home youths with the courage to seek their fortunes abroad, should meet with a successful response. W. G. G.

A JOURNEY TO CHINA. By ARNOLD J. TOYNBEE. *London: Constable & Co.* 1931. 9×6 *inches;* x+346 *pages; map.* 15*s*

This book describes a journey to the Far East made in order to attend the conference of the Institute of Pacific Relation at Kyoto, in the autumn of 1929. The route chosen was by car to Constantinople, by train *via* Angora to Damascus, thence by the Nairn to Baghdad. The author then made his way by train and sea to his destination, making a side trip to Jodhpur. He passed through Korea and Manchuria, visited Peking, and, with various other excursions, eventually returned home *via* Siberia. The whole journey took him just under five and a half months. The chapters were originally written as contributions to the press and represent his impressions while they were still red-hot. They do not appear to have been edited, with the occasional result, especially in the earlier chapters, of a good deal of repetition. Although it was the author's first visit to the Far East it is unnecessary to add that he was thoroughly conversant on paper with the conditions prevailing there. The main theme may be called the politics, in the Aristotelean sense, of the countries he visited. He gives a very vivid account of the state of much of the eastern hemisphere at the time he visited it, an instantaneous picture recorded on a plate already well prepared to receive that picture in a clear perspective. For any one who wants to know, either now or later, what the world looked like to a very well-equipped traveller going, with few exceptions, by the most frequented routes, this book should prove most valuable. If a similar one could be written, say, every twenty-five years, we should have a literary cinema film which all students of political geography could never afford to ignore. But the author is apparently not very optimistic as to the future value of the book, for he has supplied a map but no index. The reviewer, on the other hand, much as he enjoyed reading the book, felt that its true place will be from the historical point of view when we shall look back and perhaps marvel at the things which Mr. Toynbee saw, for they will no longer be there to be seen. L. H. D. B.

ARABIA OF THE WAHHABIS. By H. ST. J. B. PHILBY. *London: Constable & Co.* 1928. 9×6 *inches;* xiv+396 *pages; illustrations and maps.* 31*s* 6*d*

Arabia is perhaps the most difficult country in the world of which to write a history. There is so little of interesting matter to describe and so much warfare

to chronicle if important issues and their bearing upon changes in life and circumstance, unaccompanied by any great advance of civilization, are to be faithfully recorded. It is agreeable to find, in comparatively early Arab history, among a rather monotonous series of petty wars and tribal conflicts, the account of energetic measures taken to relieve suffering caused by famine, that scourge of undeveloped oriental countries.

Mr. Philby's main object in this book is obviously to describe the rise of Wahhabism, its varying fortunes and eventual triumph; and in so doing he has faced the inevitable difficulties nobly and overcome them to an extent which many writers would have found impossible. We may accept generally the main facts of the early history which the writer relates, but fear that some of his later information is not quite accurate. For instance, his account of the battle at Jarrab, in January 1915, between Ibn Saud and the Shammar differs on certain points from descriptions given to us at Koweit by eye-witnesses at the time. Captain Shakespear—who, by the way, had not returned to his post at Koweit as Mr. Philby states, but had been specially recalled from England for deputation to Ibn Saud—was not serving the gun, but was at a little distance from and taking no part in the actual hostilities when he was attacked and killed by some of the Shammar horsemen. We cannot agree that the subsequent campaigns of Lawrence were affected by this unfortunate incident: it was unlikely that Ibn Saud would at that moment have undertaken operations on a large scale to help the Allies, as there was more to be gained from his own point of view by dealing with local enemies and biding his time for the rest.

Our author is a little hard on the British Government in connection with the abortive Conference held at Koweit in November 1923. The position was most difficult and had been rendered more so by the obstinate refusal of King Husain to be represented at the Conference. But the British Government were right, in our judgment, in communicating to the officer whom they had selected to preside over the Conference the terms of settlement which would be regarded as most satisfactory by them. The "fatal error" lay rather with the President, who should not have allowed his attitude toward any of the delegates to have been affected by the instructions he had received, nor have allowed himself to be influenced temperamentally by the fact that he was to guide the Conference along certain definite lines should that be possible. We agree however that Ibn Saud was not likely to have accepted any form of compromise after the obstinacy shown by his opponent, which was peculiarly galling to him as it displayed an obvious sense of superiority which Ibn Saud was far from admitting.

Mr. Philby describes the last stages of the drama in an interesting fashion and leaves us, as he no doubt wishes, sympathizing with his heroes and feeling that the final result of the Nejd–Hedjaz conflict was in the best interests of both Arabia and the world at large. W. G. G.

JAPAN'S ECONOMIC POSITION: the progress of industrialization. By JOHN E. ORCHARD, with the collaboration of DOROTHY JOHNSON ORCHARD. *London: McGraw-Hill Publishing Co.* 1930. 9×6 *inches;* xvi+504 *pages; illustrations and maps.* 25*s net*

FOOD SUPPLY AND RAW MATERIALS IN JAPAN: an index of the physical volume of production of foodstuffs, industrial crops and minerals, 1894–1927. By E. F. PENROSE. *Chicago: University Press* (*London: Cambridge University Press*) 1930. 9×6 *inches;* 76 *pages.* 9*s*

Despite the large number of books dealing in general terms with Japan, the serious geographical student and the economist have long found it difficult to find sufficient material published in the languages of Western Europe to build up an

accurate and adequate picture of the economic position of modern Japan. This is more especially difficult since, as Captain M. D. Kennedy has pointed out in his recent survey of the social condition of modern Japan ('The Changing Fabric of Japan,' Constable 1930), at no time in the history of the country have changes been so rapid as since the world war and especially since the great earthquake of 1923. Professor Orchard's volume is thus particularly welcome, and he has made excellent use of the opportunity. He spent a year in the East in 1926–27 under the auspices of the Council for Research in the Social Sciences of Columbia University, and established personal contact with all ranks in Japan. The approach to the subject is interesting: the first considerable chapter deals with the pressure of population, the second with the search for a solution with the conclusion that "industrialization is more than a solution of the population problem; it is the key to the future of the country." The book then proceeds to consider the industrial background, to trace the development of industrialization, and to deal in detail with each industry and, what is of special interest to geographers, each industrial area. The subject of resources—in Japan, Manchuria, and China—is fully considered, and also the character of the labour supply. Throughout the work an illuminating comparison with England—rather than with America—is maintained. It was England who, in the early part of the eighteenth century, faced somewhat the same situation that has confronted Japan since the opening of the country. England solved the problem by industrialization, but at that time was able to obtain a virtual monopoly in the supply of many manufactured goods; Japan seeks the same solution, but at a time when the world is already widely industrialized. The second and equally vital contrast between England and Japan is also emphasized—that England possessed as a basis of industrial expansion abundant coal and iron, whereas Japan has few raw materials. But perhaps the most interesting result of the whole study is the conclusion that mergers, combines, and "rationalization" are not the natural future for Japanese industry. Village life is so strong that the people, if enticed away to the city factory, tend to return to their homes after a few brief months. So an "industrial system based on decentralization rather than upon concentration would seem to be better suited not only to Japan but to all Oriental countries," and the small producing unit is the natural one. It is here that Japan possesses the two valuable assets of a suitable labour supply and proximity of the Asiatic mainland with its huge population. It will be seen that Professor Orchard's study is one of the greatest value and importance.

Mr. Penrose's volume is the contribution of the statistician to the same problems. It was prepared for the Kyoto Conference of the Institute of Pacific Relations in 1929 and, making use of many Japanese sources, justifies the publisher's claim that in the fields covered it contains the most extensive collection of figures relating to production in Japan yet published. L. D. S.

AFRICA

TUNISIA. By Lieut.-Col. Sir Reginald Rankin, Bart. *London: John Lane* 1930. 9×6 *inches;* 204 *pages.* 12*s* 6*d*

This book is devoid of preface, of table of contents, of chapter headings, of index, of map, and of illustrations. It begins with the statement "We left England at the beginning of October," and goes on to mention matters of which the reader can have no knowledge. On p. 12 the text assumes a diary form, maintained, with interruptions, to the end; but not till p. 83, so far as we have found, is the year to which the diary refers mentioned. There the date 1906 appears in circumstances which make it reasonable to assume that it was during the autumn of that year

that the visit to Tunisia described in the book was made. It is apparently a verbatim reproduction of those diary letters which some conscientious travellers send to those left at home; without omission of any kind, and with apparently the absolute minimum of proof-reading. The last deduction is based particularly on the spelling of the place-names, which often presents a complete puzzle except on the hypothesis that the book has been set from a not very legible manuscript which the compositors were left to interpret as they pleased. Since the author's itinerary was erratic it is not always easy to make out what places are intended by the various misspellings. But we are at least sure that the ruined Roman town which he saw on an olive-crowned hill, not far from the railway station of "Medjejelbab," was not called "Drugga." M. I. N.

AFRICA VIEW. By JULIAN HUXLEY. *London: Chatto and Windus* 1931. 9×6 *inches;* viii+456 *pages; illustrations and map.* 15*s net*

This book of 450 pages on a four months' visit contains the picturesquely expressed impressions of a trained scientific observer. In consequence we have a desirable addition to the voluminous literature dealing with Eastern Africa.

The author was invited by the Colonial Office Advisory Committee on Native Education to proceed to East Africa in 1929 and furnish advice on certain aspects of native education. Accordingly due prominence is given to the many-faceted problem of the education of the black, and on the whole the author's views are sound and his many suggestions will doubtless receive consideration in the proper quarter.

Even with the help of the Government departmental heads and the best facilities for transport which the Colonies could provide, the amount seen and the variety of it is remarkable, but there is often internal evidence that the pace was rather too hot, and it is a pity that such an acute observer could not have spent, say, a full year on his mission. The extent to which, in the limited time at his disposal, he absorbed the spirit of Africa is remarkable, and further there is evidence of his desire to be always just in his appreciations; but however well equipped by training and however receptive, a newcomer has to learn a great deal before he can be quite certain that he can fully assess the true position in any particular matter. Anyway, the author has achieved much, and all who are interested in the future of British Africa will be grateful for his stimulating review.

Perhaps one of the questions most debated by European colonists is the question of direct *v.* indirect rule of natives. This has been reviewed at some length in an able manner, and the author puts his finger on a tender place when he states: "There is a more subtle influence to be guarded against. It is the reluctance of a maturer mind to allow those of less mature judgment the freedom to err. And this reluctance is intensified when the mature man has a sense of responsibility for the immature, and when he is fond of them, anxious for their success," and so on. This is perfectly true, and the author might have added that, as long as a clamant section of public opinion is antagonistic to indirect rule, every administrative officer is nervous about giving native authorities the chance of making bad mistakes. It is comparatively easy, in their present stage, to break a native authority, but it is also most difficult to find an alternative person or body of higher ethical standards. It remains to be seen whether sufficient time will be allowed for the necessary ethical development to take place, for it must necessarily be slow. It must be realized too that the native is but little concerned about the trend of affairs, for although he is deeply influenced by his ancestral beliefs he is a rank materialist, and with the passing of the present generation of elders the change of outlook of the tribes will be immense. Probably one of the greatest difficulties of the future will be to maintain the enthusiasm of the Administrative

officers for the ideal, and it may be that the stimulus may come when, as the author remarks, Applied Anthropology comes to be recognized as an essential part of African administration.

The views of a trained biologist on the importance of the question of the conservation of wild life are worthy of wide circulation, for they must carry great weight. Modern books on Africa contain too little about the marvellous wild life and the flora of that region, and it is always a delight to find some one who has sufficient knowledge and the insight which training confers. In reading this work one has been often reminded of a charming book on East Africa, published twenty years ago by Bland Sutton and entitled 'Man and Beast in Ethiopia.' It is hoped that Professor Huxley will soon make another trip to Africa and give us more of his first-hand observations and his vivid descriptions. C. W. H.

NORTH AMERICA

SPANISH VOYAGES TO THE NORTH-WEST COAST OF AMERICA IN THE SIXTEENTH CENTURY. By HENRY R. WAGNER. *San Francisco: California Historical Society* (*Special Publication No.* 4) 1929. 11×8 *inches;* viii+572 *pages; maps and facsimile MSS.*

Mr. H. R. Wagner deserves very great credit for this masterly account of the Spanish explorations along the coast of California in the sixteenth century. These begin with that of Ulloa in 1539 and end with Vizcaino's voyage of 1602. Three of them had appeared in the Society's *Quarterly*, but it is a great advantage to have everything in one volume. Chapters I to VIII have been translated by that excellent Spanish scholar Miss Irene A. Wright, of Seville, and the others evidently by Mr. Wagner himself. In several instances facsimiles of the originals have been added, but are difficult to read. In fact, a transcript of Cortes's petition should have been added.

For the composition of this volume Mr. Wagner's researches have been most thorough. He has evidently worked for a long time in the Archivo de Indias, which contains the bulk of the material here reproduced. In several instances he also refers to MSS. in well-known libraries. The result has been the accumulation of a vast mass of material which has a tendency to make the volume slightly top-heavy. Owing to this *embarras de richesse* the editor has had difficulty in sticking to his main point, which is the record of the explorations along the coast. When one has found new material one is tempted to make the most of it. In the case of Spanish documents however, owing to the Spaniard's love of *paperasses*, it is not always realized that the gist of a paper may often be given in a few sentences. There is a great temptation to give the document in full, as Mr. Wagner has done for the *actas* with Ulloa's voyage. All this makes dull reading. One gets the impression that Mr. Wagner could not at times see the wood for the trees. His notes, too, are apt to be rather long. But it was difficult not to be drawn afield with so much material at one's disposal, and great credit is due to Mr. Wagner for unearthing so many MSS. at Seville. The local inhabitant and antiquarian will doubtless enjoy all this greatly, for no doubt many of the points are to some extent controversial. In a chapter like V, wherein he describes the occupation of the Philippines and the discovery of the return route, Mr. Wagner is at his best, and his account, which is most scholarly, reads well.

Like a conscientious student he has studied and reproduced a great number of contemporary maps. Unfortunately most of these are on too small a scale to be of much use to the reader. What is required to make the volume clear is a general map giving an outline of the course followed by each explorer. Two modern

hydrographical charts are reproduced, but owing to the fact that the notes have all been relegated to the end of the volume the difficulty of following the course on these is very great. They contain far more information than the reader requires. Mr. Wagner is obviously in love with his subject and has himself made trips along the coast to verify the points mentioned in the narratives. He has also taken great pains with the translations, even going over those of Miss Wright. Many of the notes contain information of value regarding the meanings of words at that date.

In addition, for each chapter there is a bibliographical note on the sources, which should prove of the greatest value to students. In fact, there is no side of this subject which Mr. Wagner has not treated in the fullest and most capable manner. The greatest credit is due to him and to the California Historical Society for this monumental volume. H. P. B.

THE KELSEY PAPERS, with an Introduction by ARTHUR G. DOUGHTY and CHESTER MARTIN. Published by the Public Archives of Canada and the Public Record Office of Northern Ireland. *Ottawa: F. A. Acland* 1929. 10×7 *inches;* lxxxiv+128 *pages; map*

These papers, which were presented in 1926 to the Record Office of Northern Ireland by Major A. F. Dobbs, of Castle Dobbs, Carrickfergus, relate to the career of Henry Kelsey, who, from 1683 till his death about 1730, was in the employ of the Hudson's Bay Company. Through their desire to reproduce them *verbatim* and *literatim*, the editors have given an almost exact transcription regardless of the fact that the papers themselves are not in chronological order. Thus the Journal of 1689 comes after that of 1691, and that of 1694 after one of 1696. It would have been better to place them in their proper sequence, and it would have helped the reader had the places mentioned in the Journals of 1696 and 1698 been identified.

There are two Journals relating to York Fort and its capture by d'Iberville which make interesting reading, but perhaps the most important paper is that describing Kelsey's Journey to the Plain Indians in 1691. This completely refutes the charges levelled at the Company in 1752 by Arthur Dobbs, from whom these copies probably emanate. It now seems clear that Kelsey made at least two journeys to the westward. Leaving York Factory on 12 June 1690, and probably passing Deering's point on Cedar lake on 10 July, he spent the winter with the Stone Indians of the Plains. Returning in July 1691 to Deering's point, where he received a fresh supply of goods from Governor Geyer, he set off westward once more, and of this journey we have his Journal in part (pp. 5–19). Proceeding up the Saskatchewan, he and his party entered the valley of the Carrot river, along the banks of which they proceeded for some weeks. Finally they appear to have headed south in the direction of Red Deer river. Kelsey gives an account of the beliefs of these Indians with whom he spent the winter (pp. 19–25). In the autumn he returned to York whence he proceeded home to England. He appears to have been the first white man to reach the prairies and to see the Indians hunt the buffalo and the musk-ox. There is a memorandum setting forth his career in the company's service (pp. 111–117), and also copies of two letters (pp. 33 and 110–111).

As documents bearing upon this period of Canadian history are rare the discovery of these papers was most fortunate. Dr. Kenney deserves great credit for his careful transcription, but it was hardly necessary to treat these papers as Holy Writ. On p. xxvi *vix*, in spite of the *sic*, should surely read *viz*?

AUSTRALASIA AND PACIFIC

THE NEW ZEALAND NATURE BOOK. By W. MARTIN. 2 vols. *Auckland and London: Whitcombe and Tombs, Ltd.* [N.D.]. 7×5 *inches;* xvi+236, viii+188 *pages; illustrations.* 4*s* 6*d each*

The flora and fauna of New Zealand are highly peculiar. It possesses no indigenous land mammal, a number of flightless birds, the most primitive form of existing reptile, and a very curious assemblage of plants. Polynesia, Australia, South America have each contributed to its population.

A popular account of this fauna and flora is very acceptable and certain to be useful. There is an abundance of technical information on the subject scattered through various scientific journals. But in popular literature we are rather deficient, and these two small untechnical volumes are designed to fill the gap. They deal with the whole animal and vegetable kingdoms, a task which it is not easy to compress into so small a space. Certain groups can be dealt with only very briefly and detail must necessarily be omitted. Nevertheless it is a useful guide and will be specially suitable for teachers and those attending natural history classes.

Few countries have been more affected than New Zealand by the introduction of foreign species. The rabbit, stoat, weasel, cat, and a number of other animals from Europe have greatly changed the character of the fauna; in the same way the natural flora has yielded before a crowd of vegetable invaders. It is sad to think that some of the most anomalous species have been pressed almost to extinction. The huia is on the verge of disappearance; the kiwi is very rare in all but the most remote forests. Fortunately sanctuaries have been set aside where it is hoped that a fragment of the primitive life may survive for many centuries. R. W. G. H.

POLAR REGIONS

TWO POLAR MAPS. With Notes on Recent Polar Exploration. By W. L. G. JOERG. *New York: American Geographical Society Special Publication No.* 11. 1930. 10×7 *inches;* 50 *pages.* $5.00

The two new maps published by the American Geographical Society should both prove extremely useful to those interested in recent polar exploration. The scale is 1 : 20,000,000, and in the case of the Arctic map there are eleven insets showing certain regions in more detail. The Arctic map is not only an English version, but also a thoroughly revised edition, of a sheet from Andrée's Handatlas. An important new feature is the insertion of the tracks of recent flights across the Arctic Basin, a distinction being made between regions where the visibility was good and those where fog or mist made it impossible to state definitely that land did not exist. The Antarctic map is an entirely new production. It is essentially bathymetric, showing ocean depths on the layer system, and represents therefore a new and much-wanted treatment of this particular region.

The accompanying pamphlet, by Mr. Joerg, explains the distinctive points of the new maps. There are also interesting notes on methods of air navigation in high latitudes. These are followed by a resumé of political claims and rivalries in the Arctic and Antarctic. On the Antarctic map delimitations of sovereignty are a special feature, and in the case of the Arctic the various new boundaries are shown as an additional text-figure in Mr. Joerg's pamphlet. The main purpose of the maps is to show the not unexpected progress made in polar exploration since the introduction of flying; but the insertion of new, and in some cases disputed, boundaries makes their publication still more useful and appropriate at the present time. J. M. W.

PHYSICAL AND BIOLOGICAL GEOGRAPHY

GRUNDZÜGE DER PHYSISCHEN ERDKUNDE. Von Dr. ALEXANDER SUPAN. Herausgegeben von Dr. ERICH OBST. Band II, Teil 1. Das Land (Allgemeine Geomorphologie) x+552 *pages; maps and illustrations.* Teil 2. Pflanzen und Tiergeographie vi+270 *pages; maps and illustrations. Berlin und Leipzig: Walter de Gruyter u. Co.* 1930. 10×7 *inches. RM*22 *and* 12.50

The publication of these two parts of the second volume of the new Supan has been delayed, since it was expected that they would have followed more rapidly Vol. I, which appeared in 1927. Professor Obst explains that the delay has been partly due to personal causes and partly to the great mass of literature which had to be dealt with, the appearance of new researches sometimes necessitating the re-writing of chapters already completed. He is responsible for Part 1, with the assistance throughout of Dr. Karl Brünig, and contributions from Professor Fritz Machatschek, while Professor Erich Leich has written the section on the Plant Cover in Part 2, and Professor Ferdinand Pax that on the Animal World there.

Both parts maintain the high standard of scholarship and production set in Vol. I. Part 1 contains a valuable coloured map, prepared by Professor Sieberg, showing the distribution of seismic phenomena over land and sea, superimposed on one indicating the broad structural features of the land surfaces and the forms of the ocean floor. There is in addition a black-and-white soil map of the world after Glinka. In Part 2 a coloured map shows the world distribution of the chief plant formations, and, like the earthquake map, is on the scale of 1/100 M. Both parts contain also large numbers of text-figures, which include photographic views of scenery as well as sketch-maps and diagrams. Each section of both books has a detailed bibliography, and the indices and analytical tables of contents permit of easy cross-reference. The prices, finally, are commendably moderate.

Both parts have been considerably enlarged as compared with previous issues, and while the material of Part 2 is entirely new, that of Part 1 has been re-cast. It is divided into two main sections, the first dealing with the formative forces and processes and the second with the resulting earth forms. Each section is again sub-divided, the first into Endogenous and Exogenous Forces, while the land forms are discussed first under the general heading of types of relief, followed by a brief survey of special kinds of landscape, as determined either by the nature of the rocks, as in karst areas, or by particular kinds of climate, such as the humid, the arid, the nival, and so on. In his preface, in discussing the general plan, Professor Obst gives it as his opinion that for the geographer, as distinct from the geologist, it is essential that the formative forces and their effects should be grasped thoroughly before the existing land forms are studied in detail, both because only thus can he appreciate their origin and decay, and because the research student should be taught to keep facts of observation separate from morphogenetic interpretations, and to realize the fundamental value of the collection and presentation of observational data. The latter point, further elaborated in the text, seems to resolve itself into the statement that the geographer—like any other scientific observer—should be sure of his facts before he attempts either to generalize or to explain. As a doctrine this is unimpeachable; it is more difficult to decide whether the method adopted is that best fitted to attain the desired end. Thus the book begins with an account of vulcanism, a phenomenon rarely much in evidence near important centres of population or seats of learning, while the effect of running water, which can be observed in any gutter, is postponed till p. 181, after such difficult conceptions as orogenic and epeirogenic movements have been considered. Again, coasts are considered first under the work of the sea, and then again, nearly at the end of the book, in the descriptive section. The

first discussion is illustrated by diagrams and sketch-maps, the second by some striking pictures of coastal scenery. It seems difficult to believe that anything is gained by separating the two aspects of the subject by three hundred pages of closely printed matter, and the conscientious student who follows the text consecutively will find his task made heavier, both by the need for constant reference back to the first section, and by the mass of knowledge he is supposed to have acquired in the interim, while the subject of coasts has been relegated to the background. Similarly, loess is discussed in Section A under the action of wind, in Section B 1 in connection with plains of deposition, and in Section B 2 under the heading of petrographically controlled land forms. Such facts suggest a tendency to follow out a theoretical scheme at the expense of practical convenience.

The temptation to analyse and discuss in detail the volume dealing with plants and animals must be resisted. It may be noted that here, as always, the division of biogeography between two authors, working independently, inevitably gives rise to difficulties. Thus each author discusses, without reference to the other, the bearing of Wegener's hypothesis on distribution problems, though for the biogeographer the problem is necessarily one. Each discusses endemism, again a single problem to the biologist, while for the student of distribution the question whether endemic plants and animals occur, to an outstanding extent, in the same area is the main point of interest. As is so generally the case in geographical works, plant distribution is more fully and more effectively discussed than the distribution of animals. Professor Pax, in the reviewer's opinion, has not faced squarely and fully the very difficult problems of how much knowledge of systematic zoology the geographical student may reasonably be expected to possess, and what aspects of animal distribution are of most importance to him. Needless difficulties are also sometimes present, as when the question of the breeding-place of eels is mentioned in connection with Wegener's hypothesis on p. 180, while the actual migratory movements of the eels is discussed, with a map but no cross-reference, on p. 234.

Such comments do not however diminish the debt of gratitude we owe to Professor Obst and his colleagues for their arduous and long-continued labours. The new Supan is indispensable to the serious student and an invaluable work of reference for geographers in general. M. I. N.

GENERAL STRATIGRAPHY. By J. W. Gregory and B. H. Barrett. *London: Methuen & Co.* 1931. 8×5 *inches;* xii+286 *pages; illustrations and maps.* 10s

Into the brief space afforded by 239 small octavo pages the authors of this volume have attempted to compress an introduction to the principles of stratigraphy and a summary of the stratigraphical succession in all parts of the world. There is probably no living geologist but the senior author with the breadth of knowledge and the courage and experience to attempt the task. One is appalled by the torrent of facts, the acquaintance with the most varied and often obscure sources of information, and the personal knowledge of so many and widely separated parts of the Earth's surface. Two possible methods of attempting a task of such magnitude suggest themselves: one is the palaeogeographical approach—the attempt to utilize the immense variety of recorded observations in a reconstruction of the geography of past epochs; the other is the bibliographical approach, the summary of such records with full references to the original papers. The authors have attempted a middle course: they sketch too briefly past conditions and then proceed to place their own interpretation on the published work of others with only an occasional and incidental reference to the original publications. It is much to be regretted that the attempt cannot be regarded as successful. Though

professedly written, according to the publishers' note, for students, the book is unintelligible without a wide knowledge of stratigraphy, whilst with such a knowledge the book is found to be full of half truths almost useless without references. Taking statements at random, one learns in the three-quarters of a page devoted to the Rhaetic that "the Bone Bed . . . rests in places on the eroded surface of the Tea-green marls" (p. 152), but no clue is given to the horizon of the latter. In the sixteen pages on the Jurassic of the world, hemerae do not appear to be mentioned. "The most important marine Miocene Beds in India are the Pegu Beds of *the* Burma *Oil-field*" (p. 223) obscures the fact that the Peguan is mainly Oligocene and that there are at least five important fields in the country, the northernmost many hundreds of miles from the southernmost. "The Wenlock Series or Salopian" (p. 79 and pp. 252–3) suggests that the two terms are synonymous. Similarly many of the outstanding problems of correlation are lightly dismissed. On p. 79 the Ludlow Series is, following Lapworth, used as equivalent to the Downtonian. On p. 84 Downtonian is used as excluding the Ludlow, and on p. 82 as the "same species [of fish and arthropods] occur in the grey Ludlow shales, the Downtonian Series is generally retained in the Silurian." The Paniselian problem is dismissed in a phrase—"The Ypresian is an extension of the London Clay: its upper section is the Paniselian." There is a useful appendix —a list of formations extending to eighteen pages with references; but it is difficult to see the use of the forty-six figures, mostly crude line-drawings of fossils, or maps like Fig. 39 so crude that the whole Isle of Purbeck is shown as Tertiary.

L. D. S

CARTOGRAPHY

THE WORLD MAPPED. By I. J. CURNOW. *London: Sifton, Praed & Co.* 1930. 9×6 *inches;* 104 *pages; diagrams and maps.* 5*s*

In the twentieth century, as in the sixteenth, although perhaps for somewhat different reasons, maps delight a wider public than the geographers and strategists, engineers and explorers to whom they are merely essential technical equipment. Ancient maps, too, while still somewhat neglected as historical documents, attract on account of their strangeness or of their decorative qualities. It was therefore a happy idea of Dr. Curnow's to write this little introduction to the History of the Map, which, slight though it is, gives just that information and guidance which the non-specialist map-lover needs. The illustrations, ranging from the Babylonian "World Map" to a fragment of the earliest Ordnance Survey, are well chosen and beautifully produced, with the additional advantage that the reader can turn to many of the originals in the British Museum. It is a pity that the author should give currency on one page to the fable that the sphericity of the globe was a matter of controversy in Columbus' day while stating on another that "Globes were popular in the Middle Ages for navigation and also for educational purposes." Both statements need revision, and bear witness to a hasty writing which is also responsible for a number of misspellings, *e.g.* Cleomones four times for Cleomenes, Ruysh for Ruysch, Marshal for Marshall, and for many vagaries of punctuation in the Bibliography.

E. G. R. T.

HISTORICAL ATLAS, prepared by Professor WILLIAM R. SHEPHERD. 7th edition. *London: University of London Press, Ltd.* 1930. 10×7 *inches;* xi+216 +115 *pages.* 22*s* 6*d*

The sixth edition of this atlas was noticed in the *Journal* for March 1928 (p. 302). It is difficult to discover rapidly how far the revision has extended—many of the titles of maps have been altered, and some changes concern colours or symbols only—but it appears to have been considerable. The principal new maps deal with economics—*e.g.* an economic map of the ancient world and another of the

mediaeval industry of Western Europe. These are an attempt to depict more fundamental influences in nation-building than mere changes of boundaries. Other additions deal with the changes which followed the war, especially in the Near East. Another new map is that of Hispanic America, 1828–29. The new boundary of Labrador might have been shown on the map of the Dominion of Canada. G. R. C.

ECONOMIC AND HISTORICAL GEOGRAPHY

INTRODUCTORY ECONOMIC GEOLOGY. By W. A. TARR. *London: McGraw-Hill Publishing Co.* 1930. 9×6 *inches;* x+664 *pages; illustrations and maps.* 25*s*

The author of this large, well-illustrated, and not inexpensive volume repeats in his preface that it is an introductory text-book only. It deals with the distribution, mode of occurrence, uses, and origin of the common mineral substances, a knowledge of elementary geology being assumed. General principles—essentially the formation of mineral deposits—are considered in the first 82 pages, the remainder of the work being devoted to the consideration of the various groups of minerals. It is essentially a text-book for use in the United States, its value to readers in other parts of the world lies in the detailed descriptions of the principal American deposits. Thus 26 pages are devoted to the copper deposits of the United States, 1½ pages to the rest of the world; 23 to gold and silver against 7 for the rest of the world. The coalfields of the whole of Europe are dismissed in 7½ lines. The work is packed with statements of fact, and one feels a little sorry for the student who is expected to pass quickly from this introductory work to an advanced one. There is a valuable bibliography to each chapter. L. D. S.

PRODUCTION AND TRADE: A geographical survey of all the countries of the world. By E. G. R. TAYLOR, D.SC. *London: Geo. Philip & Son* 1930. 9×6 *inches;* xvi+474 *pages; maps.* 12*s* 6*d*

Although the publishers describe this volume as "an entirely new Compendium" it is not difficult to recognize a new edition of the author's 'Business Man's Geography,' published in 1923. The plan of the book remains unchanged, the format, maps, type, paper, and other details show little alteration—all of which is acknowledged by the author in her preface. It seems a little curious that the publishers should thus tend to rob the author of the credit which naturally accrues from a public demand for a second edition and at the same time rather mislead purchasers of the volume. Modern geography in its search for causes and its insistence on the importance of logical reasoning from cause to effect sometimes tends to ignore the solid basis of facts which alone constituted school geography of a generation ago. Gazetteers of the character of the present work have a very definite value in combating this tendency. The countries of the world are treated alphabetically: every effort has been made to include the maximum of information in the minimum of space. In this the author is successful, but one must protest against two serious omissions. A figure for population, still more a figure for trade, really means nothing unless the date is given, which it is not in the majority of cases. Interspersed through the text however are references to 1927 and 1928, so it is evident that the latest figures available have been consulted. The other omission is that of all references, and the business man or commercial student who would naturally turn first to such a work as this is given no help should he seek further information. The apportionment of space is sometimes a little curious: the Irish Free State gets less than Taiwan or Abyssinia; but on the whole it is fair. In all cases the range of information is wide, up to date, and generally accurate. But it is misleading to say that a railway runs from Aleppo across North Arabia to Mesopotamia (p. 435). L. D. S.

THE MONTHLY RECORD

TRONDHJEM—NIDAROS—TRONDHEIM

A note in *G.J.*, July 1929 (vol. 74, p. 90), recorded that the name Trondhjem had been officially altered to Nidaros as from 1 January 1930. The change was highly unpopular with the inhabitants, and visitors to the city last year found no trace of the name Nidaros except in the official time-tables. There has been continuous agitation to secure the abolition of this unwanted name which was considered to apply properly only to a suburb. We have now been informed by the Royal Norwegian Legation that by a law of 6 March 1931 the name of the city was altered to Trondheim from that date. We are further informed by the Foreign Office that the Bill as first introduced into the Odelsting (Lower House) proposed to restore the name Trondhjem, but that, as this proposal was not likely to obtain the necessary majority, it was agreed as a compromise to amend it by substituting the form Trondheim; this was approved by a large majority and reluctantly accepted by the local members and the Town Council, with the result that the Bill as amended was passed into law by the Lagting (Upper House). The new form, as Sir Karl Knudsen has kindly pointed out to us, is a compromise to satisfy the Landsmaal party, *heim* being purer Norwegian than *hjem*, which is the Danish form of the word. The new name is presumably pronounced *Tronhäim* (between *haim* and *heim*). Nidaros is preserved as the name of the See.

AN OFFICIAL TRANSLITERATION OF RUSSIAN

The *International Hydrographic Bulletin* for January 1931, pp. 11–15, prints a Russian transliteration table drawn up according to rules for the transcription of Russian geographical names recently published by the Geographical Society of the U.S.S.R. and now used in the publications of the Administration of Hydrography. The most noteworthy features are as follows (the P.C.G.N. renderings being added in brackets): е (*e*), even when initial (*Ye*), ж = *zh* (*j*, French), х = *ch* (*kh*), ц = *tz* (*ts*), ч = *tsh* (*ch*), щ = *stsh* (*shch*), ы = *y* (*i*), ь = *j* (′), й = *j* (*i*), ю = *ju* (*yu*), я = *ja* (*ya*). Of these *ch*, *j*, and *tz* are in accordance with German usage; *zh*, if anything, is English (formerly used by the R.G.S. and the Admiralty but abandoned in favour of *j* on account of the long usage of *j* by the Geographical Section, General Staff); but *tsh* and *stsh* are liable to give a wrong impression to any foreigner. There appear to be several misprints in the examples given, з sometimes being transliterated by *s*, etc. The letter р = *r* is omitted altogether; ь = *j* is inserted twice, and on the second occasion the asterisk, which indicates a footnote that ь is *j* only in the middle of words before vowels, is transferred to э. It would be as well to receive with caution this new system of transliterating Russian; it is by no means certain that such an orthography would be adopted if Russia totally abandoned the Cyrillic in favour of a Latin alphabet.

CONCLUSION OF THE DUTCH *SNELLIUS* EXPEDITION

The work of this important oceanographical expedition to Far Eastern waters was concluded in November 1930 after sixteen months' strenuous activity, during which an immense amount of new material for our knowledge of the waters of the Malay Archipelago was brought together, and this from the point of view both of the morphology and geology of the sea-floor, and of the composition and movements of the water. Brief accounts of the earlier cruises have already been given in the *Journal* (vol. 75, p. 565; vol. 76, p. 366; vol. 77, p. 90), based on the reports printed from time to time in the *Tijdschrift* of the Royal Netherlands Geographical Society. The work carried out between March and November of last year has been summarized in the same journal for November 1930 and March 1931, where, as in previous instalments, brief reports of the course of the

voyage are supplemented by notes on the principal results gained in the several departments. In May, June, and early July attention was concentrated on the parts of the Pacific Ocean bordering on the Archipelago, and the passages leading thence to the interior basins of the Molucca Sea, the Sangihe trough, and the Celebes Sea. In the outer waters especial care was taken to secure precise observations on the deep trough running north and south immediately east of Mindanao (named after this island in the *Snellius* reports, but marked as the Philippine deep in the map illustrating Dr. Meinesz's paper in the April number of the *Journal*), which contains the lowest spot so far discovered on the surface of the globe. The deepest sounding obtained here was 10,160 metres, and from a slightly lesser depth a bottom sample of red deep-sea clay was obtained and one of water from 30 metres above the bottom, with record of its temperature, the thermometers successfully withstanding a pressure of over 12 atmospheres. Important corrections to the chart of this region were found to be called for, the deep water continuing farther south than had been supposed: the trough is remarkably constant both in breadth and depth, and is thought by the geologist to be a result of folding rather than a rift in the crust. The lowest temperature (1·56° C.) occurred at 3500 metres, below which it increased to 2·58° C. As before, special attention was paid to the depths of the ridges over which Pacific water must pass to the inner basins, and careful observations were also made in the deep bay which indents northern Halmahera. With a depth of 500 metres within, the bay is cut off from the ocean by a ridge with only 40–50 metres above it, and this may have meant complete separation in the ice-age. Samples of the bottom showed unusual signs of stratification, but whether this implies fresh-water sedimentation remains to be proved.

The last months were devoted to cruises in various directions to fill in gaps in the previous work. It is thus possible to compare the conditions at the same spot at intervals of time and to gauge the effects of the monsoons on temperature distribution, etc. Many new data on the under-water form of the different basins (including the Weber trough) were also obtained. Altogether the *Snellius* steamed 33,700 sea-miles, and secured over 32,000 soundings, multiplying tenfold those previously available below 200 metres. Complete series of temperatures were taken at 371 stations, eight of these being at anchorages in great depths. The March number of the *Tijdschrift* gives a map showing all the routes covered during the cruises.

AN IMPORTANT GIFT TO THE SOCIETY'S LIBRARY

In memory of her late husband, Mr. Henry Yates Thompson, so long a Fellow of the Society and for many years member of its Council, Mrs. Yates Thompson has made the generous gift of some of the choicest specimens of early atlases contained in his collection, from which not a few rarities had already found their way to the Society's house during his lifetime. The gift includes some of the most important of the early folio editions of Ptolemy's Geography, accompanied by his reconstructed maps, with the addition in some cases of modern ones (modern in relation to the date of issue). The Ulm edition of 1486 is here in a fine old binding of stamped leather, with brass bosses and corner-pieces, and is altogether in a condition seldom equalled, the rich contemporary colouring of the maps being practically as fresh as when first laid on. An added interest lies in the fact that this copy came from the library of William Morris. The Rome edition of 1490 has the maps uncoloured, permitting a full appreciation of the particularly fine copper-plate engraving, which is sometimes a little obscured by heavy colouring. A partial set of the maps from Berlinghieri's metrical version, first published at Florence *c.* 1480, is a valuable supplement to the complete copy pre-

sented twenty-five years ago by Lord Peckover, the maps being in better condition and more readily read in the centre through being less tightly bound. The Venice edition of 1511 is remarkable for the manner of printing, the outlines being from wood blocks while the names are added some in red some in black from ordinary type. It includes a modern map of the world on a quasi-heart-shaped projection, the field not being extended to the point where the south pole should be. The last specimen in date, the Strasbourg edition of 1525, has an interesting history. It was bound (possibly for King Henry VIII) by John Reynes, one of the most noted binders of his reign, and was subsequently owned by Sir Walter Mildmay, of Apethorpe, in Northamptonshire, the founder of Emmanuel College, Cambridge, and later by the Earl of Westmorland. At the end, on a blank sheet of paper contemporary with the binding, a rough map of the British Isles has been drawn, with a fair number of names of towns inserted. This copy has throughout the greater part of the volume ornamental wood-cut borders, which are for the most part wanting in the copy already owned by the Society, which also lacked one of the general maps of the world.

The binding of this fine volume is in brown leather, blind-stamped with three panels in the central part of each cover, and with ornamental borders. The larger panel (placed above the others on the front cover, below on the back) shows the insignia of the Passion, supported by two unicorns with the words "Redemptoris Mundi Arma" below and Reynes's marks and initials in the upper corners. Of the smaller panels one displays the Tudor arms with dragon and hound as supporters and has in the upper corners the arms of St. George and the City of London between the sun and moon; the other shows a Tudor Rose surrounded by a verse and supported by angels, with Reynes's marks in the upper corners. Precisely similar panels (without the outer border) are to be seen on a binding of *c.* 1529 in the Victoria and Albert Museum, figured as no. 10, part 1 of 'A Picture Book of Bookbindings,' issued by the Museum in 1927. They were much used by Reynes, and in spite of the Royal Arms are no positive proof of Henry VIII's ownership.

Besides the above, the gift includes an attractive copy, in a contemporary German binding, of the first two parts of Mercator's famous atlas, as issued in 1585 and 1589 respectively. It too is in first-rate condition, and does ample justice to Mercator's work as an engraver, the maps being tastefully and not too heavily coloured. Such early issues are of interest since the type even of these parts was for the most part re-set when the third, completing the first edition of the atlas, was brought out in 1595 after Mercator's death. Lastly, there is a tall copy, coloured, of the first part of Braun and Hogenberg's great collection of views of cities published at Cologne under the title 'Civitates Orbis Terrarum.' It represents the first German issue, 1574.

These fine books will be valued not only for their intrinsic interest, but still more as a memorial of one whose interest in and support of the Library was consistently maintained for many years.

OBITUARY

HENRY OLIVER BECKIT

Henry Oliver Beckit, who died on February 19 at the early age of fifty-six, had been a member of the staff of the Oxford School of Geography for upwards of twenty-two years and its Director since the death of Herbertson in 1915. He was appointed Reader in Geography in 1919.

Beckit went up to Balliol College in 1893, before there was any School of Geo-

graphy, but showed his interest in the subject by his regular attendance at the brilliant lectures of Mr. (now Sir Halford) Mackinder, and on leaving the University turned his knowledge to practical use by writing on naval matters for the *Morning Post*. He maintained his connection with Oxford through the Vacation courses, started in 1902, and was selected by Herbertson to be his assistant in 1908. During the years prior to the war Herbertson came to rely greatly upon Beckit's powers as a tutor and as a conscientious and accurate compiler of geographical data. Many students can vouch for the soundness of his tuition, and the numerous regional studies that formed an essential and characteristic part of the candidates' work for the Diploma in Geography owe much to Beckit's guidance. It is unfortunate that so few of these, the most numerous theses of the kind in Great Britain, have been published. Many of the Oxford Wall Maps, which represented a pioneer effort by Herbertson, were due to Beckit's painstaking researches, while the same thoroughness and attention to detail was seen in his work for the River Investigation Committee under Sir Aubrey Strahan and in his contributions to the Oxford Survey of the British Empire.

In the summer of 1912 Beckit was one of the representatives of the Royal Geographical Society at the Sixtieth Anniversary Meetings of the American Geographical Society of New York, and took part in the long excursion thereafter led through the United States by Professor W. M. Davis. There he made many new friendships with American and European geographers who learned, in close contact of over two months, to appreciate his sterling qualities. On his return he addressed an evening meeting of the Society on the United States National Parks.

Increasingly heavy duties consequent upon the sudden death of Herbertson, and the war conditions, followed by a large increase in the numbers of students at Oxford after the Armistice, put a severe strain on Beckit. He was able to maintain his remarkable bibliographical knowledge and he ably assisted Professor Spenser Wilkinson to produce an English edition of Colin's 'Les Grandes Batailles de l'Histoire,' but he gave his attention almost exclusively to his pupils and his department. Particularly noteworthy were those field-classes which he conducted and on which his own keen and accurate observations were displayed. Few, if any, Englishmen had a better understanding of the tasks and methods of geomorphology than he possessed, and those who had the advantage of discussing such matters with him knew this and always benefited by his exposition. But he could rarely be persuaded to put his work in print, for he was modest about his own views and was never satisfied with anything but the best. His last publication, an essay on the South-Eastern Midlands (in 'Great Britain, Essays in Regional Geography,' ed. by A. G. Ogilvie, 2nd ed., 1930) invites admiration for its clarity and its conciseness, but also calls for regret that its author never told us all he knew of his own region and his own particular subject. A work on landforms long ago begun remained unfinished at his death. Yet Beckit in no sense restricted himself to one branch of geography. Only one who has seen his papers can appreciate his immense labours, often barren of result, on the proposed map to show distribution of population in Great Britain, and this was but one of his fields of study. It is indeed a misfortune that circumstances and his own temperament never allowed Beckit to do justice to himself. He died at work and retained almost to the end those boyish characteristics which endeared him to all his pupils and friends.

A. G. O.
J. N. L. B.

MAJOR E. A. FITZGERALD

Major Edward Arthur Fitzgerald, who died at Marsden Manor, Cirencester, on January 2, had been a Fellow of our Society since 1893, and was for some years at the end of last century very well known as a traveller and mountaineer. In 1894, at the age of twenty-three, he took some part in Sir Martin Conway's traverse of "the Alps from end to end," and then started with Mathias Zurbriggen for New Zealand to make a first ascent of Mount Cook, but was forestalled by local climbers. On his return he gave an excellent account of his journey in 'Climbs in the New Zealand Alps,' published by Fisher Unwin in 1896, and then proceeded to the enterprise by which he is best known, the expedition to climb Aconcagua. With Mr. Stuart Vines (surveyor), Mr. Arthur Lightbody (engineer of the Transandine Railway), Mr. Philip Gosse (naturalist), and Zurbriggen, two Pollingers, and Lanti (guide and porters), he established a base camp in December 1896 at the mouth of the Horcones valley, and methodically explored the approaches to the mountain. After some unsuccessful attempts a party of four—Fitzgerald, Zurbriggen, and two porters—got above 22,000 feet, and Zurbriggen went on alone to make the first ascent to the summit on 14 January 1897. During further prolonged stays at the 19,000-feet camp, Fitzgerald made several more attempts, but was always beaten by mountain-sickness; but on 12 February 1897 Vines and Lanti made a second successful attempt on the summit. Later in the season, during the completion of the surveys, Vines alone reached the summit of Tupungato, the second highest peak of the neighbourhood.

On the return to England, after long delay due to typhoid fever, Fitzgerald and his companions wrote between them an excellent book: 'The Highest Andes,' published in 1899 by Methuen & Co., with fine illustrations and a careful map drawn by Lightbody from the surveys of the party. Not long afterwards Fitzgerald went to the war in South Africa with the Imperial Yeomanry, whence he received a commission in the 5th Dragoon Guards, and transferred later to the Inniskilling Dragoons, reaching Field Rank in 1912. After his South American journey he took no further part in geographical work, and thus it comes that the news of his death recalls few memories less than thirty years old. His talents and fortune had been withdrawn too early from the field.

CORRESPONDENCE

CAPTAIN JAMES COOK

May I point out certain errors in the review of 'Captain James Cook' by Sir Joseph Carruthers, published in the *Geographical Journal* for December 1930, pp. 568 and 569? The reviewer accepts without question the author's ill-founded animadversions on John Ledyard and is led into several mis-statements which in the interests of historical accuracy need correction.

In 1781 there was published in London by E. Newbury the anonymous volume entitled, 'Journal of Captain Cook's Last Voyage,' etc. This was the first full report of Cook's final voyage to be printed. As the personal journals of the expedition had been commandeered by the Admiralty at Macao in China in December 1779 (*not* after the arrival in England in 1780, as Sir Joseph Carruthers states on pp. 60, 80, and 86), this publication was surreptitious. Its author has never been positively identified, tradition alone having assigned it to the pen of John Ledyard, who was a corporal of marines on the *Resolution* during the voyage. Modern scholarship however attributes the work to John Rickman, second lieutenant on the *Discovery*. (Judge F. W. Howay, in his Presidential Address

before the Royal Society of Canada, May 1924. See *Transactions*, vol. xviii, Series III, p. 17. See also *Washington Historical Quarterly* for January 1921, vol. xii, p. 51.) All the evidence contravenes the supposition of Ledyard's authorship. Ledyard lived on the *Resolution*, whereas the anonymous author writes from the *Discovery* ('Anonymous' of 1781, 1st edition, pp. 215, 226, 258, 270, 277, 284, 308). Any one conversant with Ledyard's style, as evidenced in the only book which he ever wrote (mentioned below), knows at once that he never penned a word of the anonymous volume. His style is pungent, direct, and easily recognized by many curious turns of expression peculiarly his own, and none of these are to be found therein. We may conclude therefore that he was not the author of the book in question. Consequently the case which Sir Joseph Carruthers builds up against Ledyard on this foundation falls to the ground, and the difficulties felt by him in reconciling the various texts of 'Ledyard' (?) vanish (*cf.* his 'Captain James Cook,' pp. 75, 76, 86, 87, notes). Most of the editions enumerated were of the 'Anonymous' of 1781. Ledyard had nothing to do with these, and if they spread abroad in Europe an unfavourable impression of Cook, John Rickman should be blamed, not Ledyard.

The only book that John Ledyard ever wrote was 'A Journal of Captain Cook's Last Voyage . . . faithfully narrated from the original Manuscript of Mr. John Ledyard,' published in Hartford, Connecticut, by Nathaniel Patten in 1783. This rare volume of 208 pages, of which only about a dozen copies are known to exist, is of prime importance to all students of Captain Cook, because it is the first published narrative of an actual eye-witness to his murder; yet it has never received due notice from historical commentators. Sir Joseph Carruthers alludes to it (p. 60, note), but confuses it with the 'Anonymous' of 1781 above, and all his statements about it on p. 61 are therefore wrong.

This pitfall has trapped many, and it is high time that the need of discriminating between the two books should be pointed out. It appears that Ledyard's book of 1783 was very hastily gotten together and as the author had surrendered his own notes to the Admiralty and never recovered them, it was natural for him to make use of the best book of the voyage existing at the time—the 'Anonymous' volume of 1781—to supply technical and other data regarding distances, courses of the vessels, etc., when writing his own text. Unfortunately, the publisher, Patten, saw fit to go even farther, and the last seventy pages of the Ledyard volume are reprinted bodily from the earlier work without change. Undoubtedly, it is this which gave rise to the idea that Ledyard wrote the anonymous book.

Ledyard's own narrative was published in two separate portions, a month apart. Subsequently these were incorporated into a single volume so as to be indistinguishable. Part I appeared late in June 1783, and Part II at the end of July. Jared Sparks, the biographer of Ledyard, intimates that only Part I was prepared by Ledyard and that Part II was issued as an afterthought by Patten to round out the story, as Part I breaks off more than a year before the end of the voyage. Most probably this is the truth, and as Ledyard left Hartford for good early in May 1783, it is unlikely that he ever read the proofs of Part I or had anything whatever to do with Part II containing the verbal reprint from the anonymous publication of 1781. (Sparks's 'Life of John Ledyard,' Cambridge, Mass., 1829, p. 118.) It is not to be implied from this use of the 'Anonymous' text that Ledyard sanctioned the author's argument in the rest of the book or that he adopted its interpretation of events. The matter of the two publications is quite distinct, except for the portion reprinted, amounting to about one-eighth of the anonymous volume. This covers the period subsequent to the death of Captain Cook from the middle of June 1779 to the return of the ships in 1780.

From the foregoing it will be evident that Ledyard did not get "his account

before the public three years earlier than the Admiralty," as your reviewer states on p. 568, but only *one* year, and not in Europe at all, as Carruthers states (p. 86, note). On p. 569 the words "rewrote his journal" and "ran through several editions" are incorrect. Ledyard's book was never republished as such, although parts of it (and these not always the most significant) were incorporated by Jared Sparks in his 'Life of John Ledyard,' published in Cambridge and London in 1828, long after Ledyard's death. Practically all that Sir Joseph Carruthers has to say about Ledyard is tainted by his fundamental error in failing to distinguish properly between the three books mentioned: the 'Anonymous' of 1781 (by Rickman), the 'Narrative,' by Ledyard (1783), and the 'Biography,' by Sparks (1828).

Sir Joseph's book is far from "a complete refutation of Ledyard and his unwary followers," as the review states, although to give the reasons in detail here would occupy too much space. And an impression utterly contrary to the truth is conveyed by the statements that Ledyard was "devoid of personal knowledge on most of the events he chronicles and by the admission of his own American editors, prone to exaggeration and of a defective memory." It must suffice here simply to take direct issue with such censure and leave its disproof for another place.

Sir Joseph Carruthers treats Ledyard as though the latter had put out his book as propaganda against Captain Cook, with an ulterior motive of detraction and criticism. This view is quite unfounded. Ledyard's purpose was much simpler. Being an impecunious young man without a job or prospects, he wrote his narrative as a "pot boiler" and sold it to Patten for twenty guineas (Sparks, Cambridge 1829, p. 36). Sir Joseph avers (p. 61) that "a committee was formed and funds raised to publish Ledyard's story" and that they appointed an editor who noted a "proneness to exaggeration on his part" which "had to be corrected." No authority is given for these statements and, as they do not accord with the facts as hitherto known, they may be dismissed as erroneous. Ledyard's book of 1783 had no editor and no preface, only a dedication to Governor Trumbull. The phrase "proneness to exaggerate" again repeated by Sir Joseph on p. 66 as a statement by Ledyard's biographers (here evidently meaning Sparks) cannot be found in Sparks's book, although it may have been culled from the "advertisement" of the anonymous volume of 1781, where the editor suggests that his author may have sometimes "exaggerated circumstances" and let his prejudices prevail over his candour in representing characters. But this, as we have shown, refers to John Rickman; certainly not to Ledyard.

With regard to Ledyard's attitude towards Captain Cook, it was candid and impartial. He does not always see eye to eye with him in the transactions of the voyage, but this is not surprising in view of the vast disparity in their positions. Sparks states that Ledyard was accustomed to speak with high respect of Captain Cook, "whom he honored for the high station to which his merits had raised him and whom he admired for his many and good qualities" (Sparks, p. 120). This is undoubtedly true. Ledyard alludes to "the consummate accuracy of Cook" (p. 100), his "genius" (p. 100), his liberality to the natives (p. 64), and to his forgiveness (p. 21). On the other hand, he does not hesitate to express himself freely when he sometimes felt that Cook took long chances and that his treatment of the natives was unduly severe. This however is no more than has been thought by many others, even better qualified to judge than himself, and when it is only the honest expression of opinion it does not argue any improper animus or disrespect.

'Captain James Cook' is vitiated by misquotations, distorted quotations, and partial quotations. On p. 54 Sir Joseph prints a direct quotation of words voiced by Captain Cook. The source is not mentioned, and yet it is well known that

quotations of the commander's spoken words are practically non-existent in all the Cook literature. On pp. 65 and 66 the author tries to distort a few words of Captain James Burney ('History of North-Eastern Voyages,' etc., London 1819, p. 280) into a severe condemnation of Ledyard for unreliability and proneness to exaggerate, while in the very next sentence (not quoted) Burney acknowledges Ledyard's sincerity and speaks highly of the worthiness of his later writings, mentioning particularly "his celebrated commendation of women in his Siberian Tour."

This citation of Burney against Ledyard is especially reprehensible because Burney actually was most favourably disposed towards Ledyard. Witness the following, quoted from the same book (p. 278): "Ledyard had the most romantic enthusiasm for adventure perhaps of any man in his time." See also p. 279 and p. 252, where Burney states that Ledyard "distinguished himself for enterprise" by volunteering his services to Captain Cook on a difficult mission. Captain Cook accepted his offer and alludes to the incident in his narrative of the voyage, mentioning Ledyard by name and characterizing him as an "intelligent man"—a rare compliment coming from this eminent source. These extracts ought to completely dispose of the author's "valuable piece of evidence" (p. 65) against Ledyard. It is a characteristic sample of his entire arraignment of the latter.

Another specimen of the author's method of excoriating this man is seen in Chapter VIII, which is so faulty in most places that one can scarcely deal with it intelligently. Sir Joseph Carruthers is trying to show that Ledyard asserted that Cook accepted deification and was worshipped as a god, though he (Ledyard) was not present at the ceremony, and could not know anything about it because he stood outside of the 10-foot stone walls of the temple enclosure. He prints in support of his argument (on p. 77) the following, which he says are Ledyard's words: "Cook was then conducted to the Morai, a sacred enclosure which none but the chiefs and their attendants were allowed to enter." But they are Sparks's words ('Life of Ledyard,' 1829, p. 89) not Ledyard's, and they are not even used by Sparks in connection with any temple ceremony, but in connection with a tabu laid by the chiefs upon a potato patch to be used for the instrument tents outside of the Morai on the day Cook first landed, 17 January 1779. What Ledyard actually said was: "This [Morai] being a sanctified spot and the people in general forbid to approach it, Cook was left, much to his satisfaction, attended only by a few chiefs and their domestics. . . . The first business Cook wished to accomplish was to obtain a commodious spot to erect his tents upon . . . and observing a square potato patch between the S.E. side of the Morai and the sea," etc. (p. 105).

Neither Ledyard nor Sparks mentions the "temple ceremony" of Captain King within the Morai, as asserted by Carruthers. "The ceremony of being anointed with coconut oil" (Sparks, p. 90) occurred "the third day after our acquaintance" (Ledyard, p. 109), and was held by the priests at a small pond outside of and west of the Morai. Ledyard attended this at the invitation of Captain King and describes it on p. 110. King mentions it near the middle of Section I of the official account in connection with the artist, Webber. According to King, there were two ceremonies—a fact entirely overlooked by Sir Joseph Carruthers.

The foregoing demonstrates that all of Carruthers's argument on pp. 77, 78, 79, is vitiated by his failure to apprehend that the quotations which he makes (and with a number of verbal errors) apply to the tabu at the tents and not to any temple ceremony. It was the tabu that Cook consented to, not the temple worship, and it was the mutual breach of this solemn tabu around the instrument tents that Ledyard says was the origin of the ensuing disasters. It seems clear therefore that the author has failed in his attempted impeachment of Ledyard and that his

own errors of interpretation are a large factor in the conclusions that he draws. Ledyard makes no statements whatever about Cook's acceptance of deification. His words, correctly quoted by the author in italics on p. 87, imply that Cook did not understand the nature of the ceremonies at all, being thus in agreement with King in the official report.

On p. 80 most of Sir Joseph's allegations are wrong. Several have already been answered in this note, but it remains to point out that the Admiralty did not publish an abbreviated account of the third voyage prior to 1781—an egregious error, as is the statement, "It is certain that it was written by Ledyard."

It is submitted that whatever estimate one places on the merits of this young soldier as a historical character, he by no means deserves the sweeping condemnation bestowed by this book.

HOWARD PALMER,
Vice-President, New London County Historical Society.

25 *February* 1931.

Note by the Editor, G.J.

Mr. Howard Palmer alleges against us that our reviewer ignores the fruits of modern scholarship in believing, with most people until now, that Ledyard wrote the anonymous account of 1781. It is admitted that Ledyard used it extensively in writing his book of 1783; and his publisher, if not Ledyard himself, did not scruple to lift into the later book a whole long section of the earlier: hence the not unnatural, if erroneous, attribution, accepted so late as two years ago in the Bibliography of James Cook issued by the Mitchell Library at Sydney.

In May 1924 His Honour Judge F. W. Howay delivered a Presidential Address to the Royal Society of Canada on "The early history of the North-West Coast" (*Trans. R.S. Canada*, section ii, series iii, vol. xviii). He remarks that the authorship of the anonymous Journal of 1781 has been sometimes attributed to Ledyard and sometimes to King, but "From the internal evidence afforded by the Journal itself I have concluded that it was written by John Rickman, the second lieutenant on the *Discovery*, and later in the same position on the *Resolution*." None of the evidence is set out, and the conclusion remained unsupported until a few months ago, when Zimmermann's 'Reise um die Welt mit Capit. Cook,' originally published at Göttingen in 1781, was translated by Messrs. Michaelis and French, with an introduction and notes by Judge Howay, and issued by the Ryerson Press of Toronto as a volume of the Canadian Historical Studies. It did not reach England until after our review was published in December last.

So much for our alleged neglect of modern scholarship. Now that Judge Howay has stated his case we may readily admit that it is a good case, and that several sentences of the review, and a good deal of Carruthers's criticism of Ledyard, require reconsideration. But that does not alter the fact that for over one hundred years the public of the United States and of Hawaii (not the European public, as Mr. Howard Palmer suggests) have been misled by allegations against the name and fame of Cook, having their origin partly in the Journal of 1781, partly in Ledyard's volume and in Sparks's life of Ledyard. Sir J. Carruthers set out to refute them, and in the opinion of our reviewer he has succeeded. On some points of detail we may quote from the comments which our reviewer makes after careful study of Mr. Palmer's letter.

"The section of the Ledyard volume (38½ pp.) which is reprinted from the 1781 Journal concerns only events from 19 June 1779 onwards. It has no relevance to anything connected with Captain Cook. For all statements about Cook in the 1783 volume Ledyard is directly responsible. Mr. Palmer says that 'The

last 70 pages of the Ledyard volume are reprinted from the earlier work without change.' The reprint begins on p. 170 (Ledyard) and ends on p. 208.

"On p. 119 of the Sparks life there is a candid criticism of Ledyard's methods which Mr. Palmer might care to study. Among other remarks is one that he imagined his superiors in office 'to have been actuated by motives which could scarcely exist.'

"Mr. Palmer is mistaken about the *morai* ceremony and the *tabu*. Captain King states clearly that the ceremony at the *morai* took place on the evening of Cook's first landing, exactly as Carruthers describes it (Ledyard was not at this ceremony, and gives a totally incorrect account of the proceedings); that the negotiations for a *tabu* over the potato patch took place the next morning, without any particular ceremony, and that the temple ceremony described by Ledyard as occurring on the third day was a mere replica of the earlier one. The allegation that Ledyard was present at this replica rests only on Ledyard himself, and his habit of putting himself forward as a leader where he was merely one of a party (compare his account of the inland expedition with King's) must gravely discount his reliability even in minor matters. Again, if Ledyard was in the party which accompanied Cook to his death, why doesn't he say so? Burney, writing forty years later, says he was; but Ledyard, writing four years or so later, does not make the claim.

"Ledyard's responsibility for the slanderous allegations which coloured all U.S.A. notions of Cook for a hundred years is further substantiated by two more details which Mr. Palmer neglects:

"'The alleged desecration of temple timber images is Ledyard's, not Rickman's. He definitely involves Cook in the business, whereas King with equal definiteness states that he (King) carried through the transaction. It is on this business that the charge of Cook's bullying the natives chiefly rests.

"Sparks directly attributes similar allegations to Ledyard:

"' 'The precipitancy of the officers, and of Cook particularly, which was the primary cause of the tragical issue, was kept out of sight by the authorized narrators. . . . On this point Ledyard's narrative is full and satisfactory.'

"I consider therefore that while Sir J. Carruthers's ascription of the 1781 Journal to Ledyard must be abandoned, and his criticism of that volume transferred to Rickman, yet he is right in regarding Ledyard as the chief authority on whom American writers have mistakenly relied, and entirely right in claiming to have refuted their defamatory statements."

MEETINGS: SESSION 1930–1931

Tenth Evening Meeting, 23 March 1931. The President in the Chair.

Elections: Capt. Eustace John Bartleet, B.SC., A.I.MECH.E.; Lady de Robeck; Lt.-Col. Cecil Moncrieff Eales, I.A.; Jack Bezar Goodson, B.A.; Major Harold W. Hall, M.C.; Percival Roy Hatcher, B.SC.; The Rev. Canon Ernest Richard Wright Higham, M.A.; Miss Alice Agnes Hunt; Arthur Rowland Jones; Rt. Hon. The Countess of Kintore; Douglas Stuart Mullinger Lockhart, B.A.; Mrs. Muriel E. M. MacGregor, B.A.; Kenneth Duncan Morrison; Arthur Neale; Denis Norwood, M.A.; Geoffrey Parker; Sir Percival L. D. Perry, K.B.E.; Mrs. Maude Mary Perston Rudduck, F.R.H.S.; Charles Rodney Segrave; Miss Nesta Threadgold; Mrs. Jane Elizabeth Tolson-Shaw, L.L.A.

Paper: Liberia in 1930. By Dr. Cuthbert Christy.

Sixth Afternoon Meeting, 13 April 1931. The President in the Chair.

Paper: Island Arcs and Mountain Building. By Mr. Philip Lake.